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HENRY WOODWARD, F.G.S., F.Z.S.

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AND

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new light as to the condition of the North American Continent in Secondary times. The Surveys of the United States, and those of our Indian possessions, continue to make known the vast natural resources of their respective countries, and by their labours to add greatly to geological science.

These we have had from time to time the pleasure to record, as also the work in progress upon our own Insular Surveys.

New facts and fossils continually turn up, needing to be published as speedily as possible.

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No. LXVII.—JANUARY, 1870.

ORIGINAL ARTICLES.

I.—On the Contraction of Igneous Rocks in Cooling.

By David Forbes, F.R.S., &c.

UPON commencing, in 1847, the special study of the igneous rocks, I, no doubt in common with many others, took for granted the conclusions arrived at experimentally by Professor Bischof, of Bonn, as to the amount of contraction which such rocks would undergo when passing from the state of hot liquidity to that of cold solidity; and I did so, not after any critical examination of the details of Bischof's inquiry itself (the most important of which are contained in a memoir published in Leonhard und Bronn's Jahrbuch for 1841), but merely in deference to authority, since these conclusions had apparently received unquestioned acceptation from geologists in general.

Living at that time in Norway, a country pre-eminently fitted for the study of eruptive rocks on the large scale, I soon found, however, that these conclusions did not seem to be at all in accordance with the facts which every day presented themselves in the field. I could nowhere find evidence to prove that any such immense contraction as 25 per cent., or one-fourth of its volume in granite, or 10 per cent., one-tenth of its volume in basalt, as assumed by Bischof, had ever taken place in nature. Even when great masses of granite were seen interposed between rigid rocks of other character, they were not found to present large fissures or rents of contraction, or to possess a well-marked porous, honeycombed, or cavernous structure, such as might be expected in case any such enormous contraction in volume had really taken place.

On the contrary, although some small amount of contraction had undoubtedly taken place, these rocks, as a rule, appeared to be so solid and compact in texture throughout, as to indicate that the space which had been originally filled up by molten rock differed but comparatively little in volume from that which the rock now occupies.

These discrepancies led me to consult the original memoirs of Bischof, and to repeat his experiments on a more extended, and, in some cases, a much larger scale, using as materials the basaltic melaphyre of Staffordshire, commonly called the Rowley Ragstone, seems to me that the amount of contraction would be greater tha the mere difference between the dimensions of the moulds when col and that of the cooled blocks? I ask this question because I a engaged in revising a paper of mine relating to the cooling of th earth, in which I am inclined to support the view of the solidity the globe, though I feel strongly the inadequacy of our means arriving at any certainty on the subject."

In reply to this I wrote Mr. Fisher to the effect that allowan had been made for the expansion of the moulds, amongst oth means, by measuring the moulds whilst hot; but it appears no from his published paper, that he has not modified the expressio made use of in his comments upon my experiments.

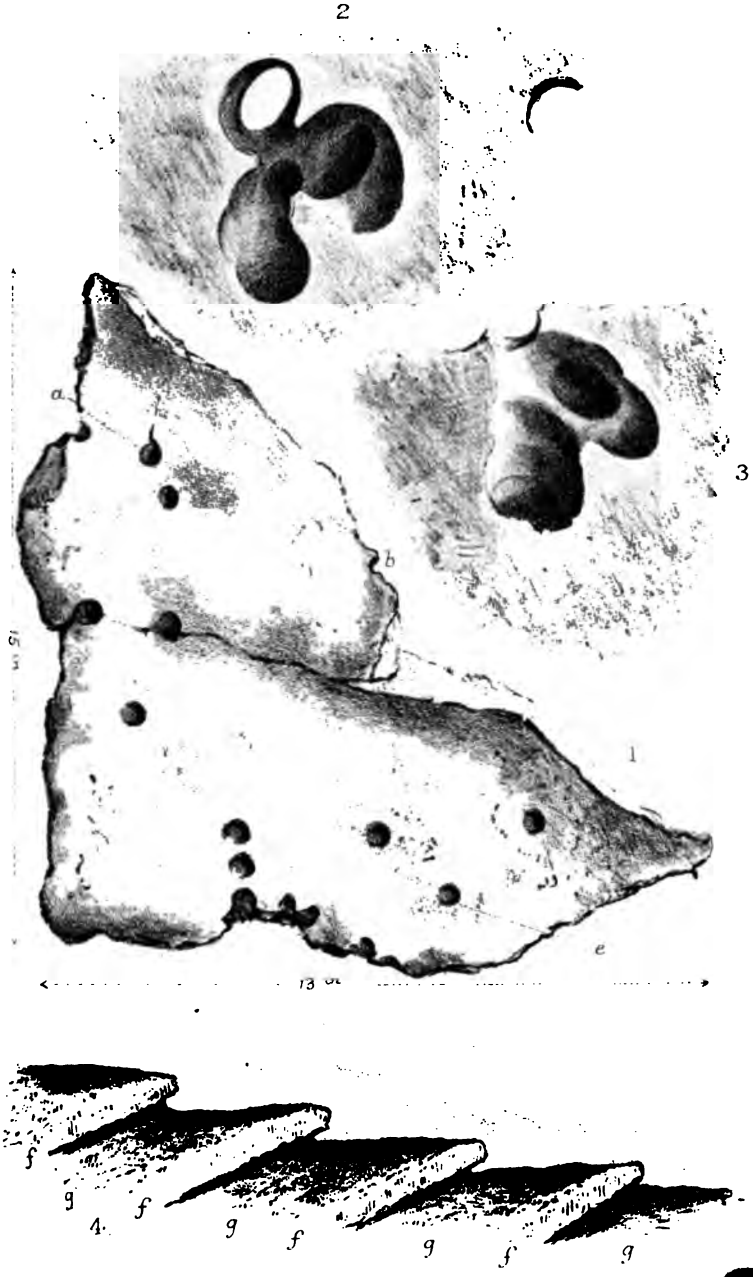
Mr. Fisher's paper is a purely mathematical one, and altogeth beyond the scope of my present communication; yet what I ha already stated is but another proof of the tendency which mathem ticians apparently have to treat experimental data in their own wa overlooking the vital importance of thoroughly sifting their eviden or premises on which they base their elaborate reasonings. Th recent notorious case of the Pascal forgeries is but an instance i point; and a representative of the Press pleasantly remarked th nobody but a mathematician could have been deceived by suc imperfect evidence.

II.—On some supposed Lithodomous Perforations in Limesto Rocks.

By John Rofe, F.G.S.

[PLATE I.]

Within the last few months considerable interest has be revived on the question of the origin of certain small exc vations or borings which have been found in limestone rocks different localities in Sicily, France, England, and Wales. The fi public notice of them in England was by Dr. Buckland, who attention, when at a meeting of Geologists at Boulogne in 1839, w called to some borings which had been found in the under-surfa of a ledge of Carboniferous Limestone rock in the Boulonnais. Aft this Dr. Buckland examined some similar borings which the Rev. Stapleton had observed near Tenby, and described both cases in communication to the Geological Society in 1841. About the same ti that Dr. Buckland was engaged with these excavations, M. Consta Prévost found some similar perforations on Monte Pelegrino, ne Palermo. Mr. C. P. Jopling discovered them in Furness in 1843. Bouchard Chantereaux, who met with them in the Bois des Roches, the Bas Boulonnais, has published a memoir on the subject, the res of many years observation, to which I shall have occasion again refer. Mr. Pengelly met with them in many localities in the Torb district. They were also found on Birkrigg Common by Miss Hodgson, of Ulverston, and were described by her in vol. vii. The Geologist, p. 42. Mr. Darbyshire has discovered them in Nor



G. P. De Wilde del et lith.

Perforated *Limestone* — Birkrigg Common.

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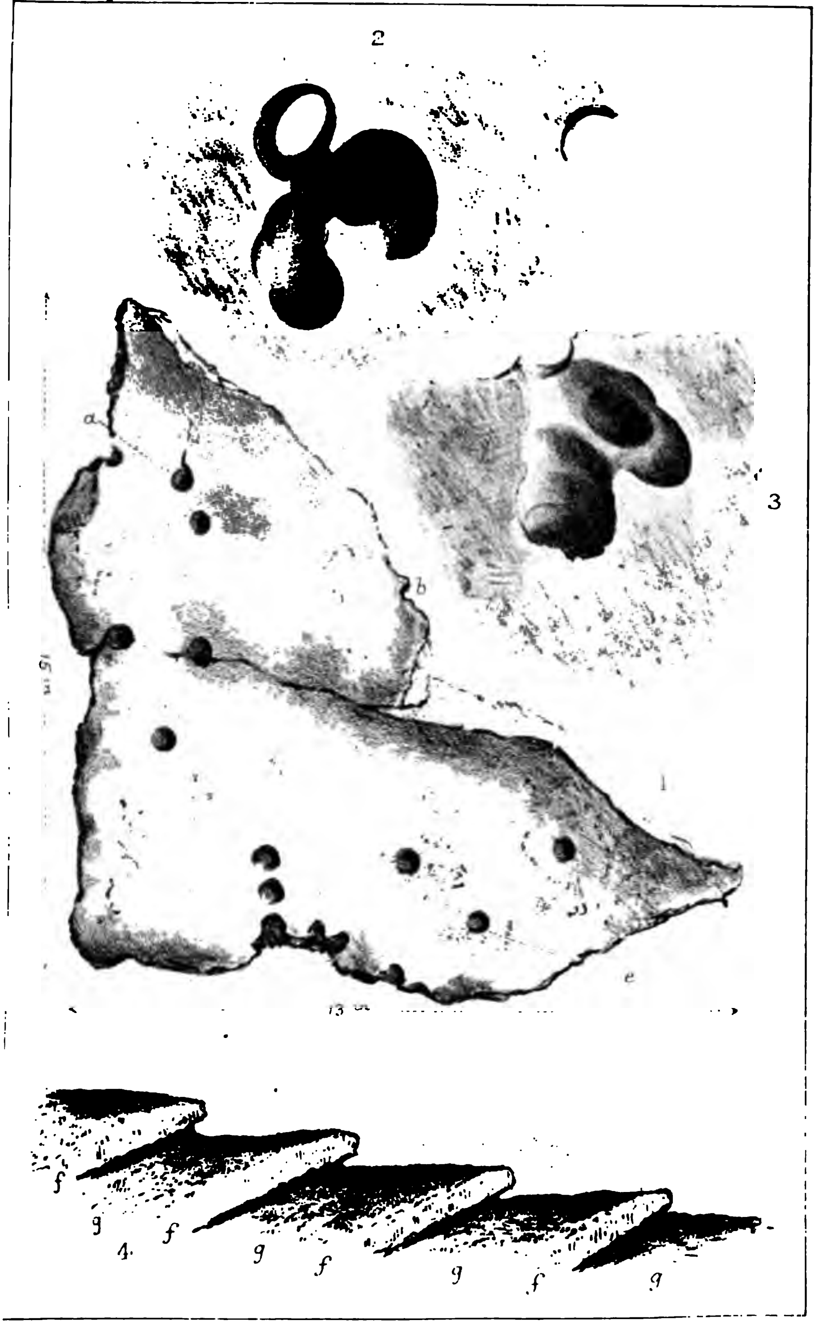

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Perforated Limestone _ Birkrigg Common

Wales. Mr. D. Mackintosh found them in West Lancashire and in Derbyshire, at greatly varying altitudes; and in the last November number of the GEOLOGICAL MAGAZINE they are described by the Rev. T. G. Bonney as found at the Ormeshead. They have also occasionally been alluded to by other writers as proofs of the elevation of the coast in various places.

The origin of these holes has been assigned to various agents,—to atmospheric action or weathering—to the work of *Pholades* before the upheaval of the rock from the ocean—to snails—to a chemical action combined with one of these, and to a mechanical action of water or other abrading agent. Before, however, we consider which is the most probable theory, it will be well more fully to describe the holes and the situations in which they are found. They appear to be confined to Limestone rocks, or, at least, they have only been noticed in them hitherto, and with perhaps the exception of Monte Pelegrino (the age of which I am unable to speak to with certainty), to the upper Palæozoic rocks, and to the hard crystalline or semi-crystalline strata in them; and from the descriptions given by the above observers, they appear to be similar in their position and in their size, but those found by Mr. Pengelly are described as somewhat different in shape. I have personally had the opportunity of examining only those found at Birkrigg, and therefore in my description will confine myself principally to them.

In May last I was present at a meeting of the Geological Society, when a paper on "Apparent Lithodomous Perforations," by Mr. Mackintosh, was read, and I heard the discussion which followed; but having previously seen some specimens belonging to Miss Hodgson, I must confess I was not satisfied with the conclusions arrived at.

On my return into Lancashire, I went to Ulverston, and having called on Miss Hodgson, was guided by her to the locality in question, which I found to be on Birkrigg Common, near the summit of a hill of mountain Limestone, overlooking Morecambe Bay. The situation of the rocks is shown on the six-inch scale Ordnance Map of Lancashire, plate 16, about two and a half miles south of Ulverston, and they are there called "Flat Limestone Rocks," and are, where the specimen (Fig. 1) was found, about three hundred and fifty feet above the sea. The common is crossed by several nearly parallel outcrops of thin but hard beds of mountain Limestone, all dipping slightly in the same direction, but parted by pasture several yards wide, growing evidently on the partially denuded surface of the intervening softer beds (rotten rock), and leaving the basset edges of the harder beds exposed, and frequently slightly overhanging from one to two feet above the pasture. These overhanging ledges form a shelter from the prevailing winds, and the sheep feeding on the pasture creep under them for protection, and by long and repeated action the wool on their backs has put a bright polish on the under surface of the ledge, showing the power of prolonged friction on the hard Limestone, even by so soft a substance as wool.

The ideal section, Plate I, Fig. 4, will give a notion of this arrangement, *ff* representing the strata of hard rock, and *gg* the softer beds, which are from 100 to 150 feet from ridge to ridge. The dip of the strata is greatly exaggerated, as it does not exceed 9°.

It is under the above-named ledges that the borings in question occur, and generally near the edge, as will be seen in Fig. 1, Pl. I; but the hole marked *b* is seven and a half inches from the outside. The holes are bored upwards into the rock, and all have circular openings of nearly the same size, a little more or less than seven-eighths of an inch in diameter; but the chambers within the rock vary very much in size and shape; some are nearly but not quite straight, and about the same area of section as at the opening, whilst many branch into several chambers, as shown on a larger scale in Fig. 2, which is a horizontal section of the chambers, of which the opening is seen at *a* in Fig. 1, the oval aperture being the opening in perspective. Fig. 3 is a vertical section of the chambers connected with the hole near the middle of the fracture shown in Fig. 1, the section of the opening being at the upper part, and the chambers, it will be seen, are of greater diameter than the opening. I have forwarded the specimen figured in Plate I. to the British Museum.

The burrows described by the above-named authors, in those cases in which the direction of the borings is named, are stated to be bored upwards from the underside, or, where on the face of the rock, in an upward direction.

The Rev. T. G. Bonney, in his paper in the November (1869) number of this Magazine, describes the holes as being bored generally upwards, but of those described in page 486, No. 5 descends slightly, and No. 6 is at right angles. The borings, however, shown in Fig. 1 in the plate illustrating his paper have very much the appearance of being vertical sections of burrows, the front halves of which have been removed with the face of the rock by weathering or fracture, leaving the other halves as the curved chambers shown in that plate, and very similar to some fractured chambers at the lower edge of Fig. 1, Pl. I, of this paper: in that case (5) might be a chamber from another boring, and (6) would clearly be a chamber from (8). I am the more inclined to think this to be the case, as Mr. Bonney describes some of the channels to be much weathered.

We may now consider the origin of these holes: first, then, as to atmospheric action or weathering. The appearance as well as the situation of the holes is altogether opposed to this theory, as they are mostly on the under-surface of the rock, where no rain could possibly get to them, either directly, by splashing, or by percolation; and they are generally in sound hard beds, and in those cases where they are on the face of the rock, they are stated to be in sheltered situations and bored upwards. Surely we have no right to assume such partial atmospheric action as would account for holes so deep in proportion to their diameter, and particularly as, from their position, moisture could not lodge in them. It has been suggested that possibly they might be caused by a decomposition of the rock, by which fossils have been loosened and have fallen out, leaving the cavities; but this is met by the fact that most, if not all, the holes are in hard rock, in which metamorphism has obliterated almost every trace of organism: even when fossils are found, the holes are sometimes bored through them, or partly through them, and partly through the rock. Miss Hodgson, to whose paper I have alluded, has a specimen in which the hole is bored partly through a *Cyathophyllum* longitudinally, and partly through the Limestone, which appears to be softer than the coral, as the hole is rather flatter on the side passing through the coral, showing that the worker inclined to the softer material. I believe generally, but certainly in the mountain Limestone of Lancashire, in every case where there are fossils, they are not acted upon by the weather so easily as is the rock in which they are imbedded, and therefore would not be likely to decay and fall out of their beds and leave holes; but, on the contrary, the limestone weathers away from them, and in many cases leaves the fossils beautifully clean, well displayed, and projecting from stone, as must be familiar to any observant person on the roughly built boundary walls in any fossiliferous Mountain Limestone district. In all these cases, rain or other water has free access to them, first to disintegrate the matrix, and then to wash away the debris.

The action of rain, or of the carbonic acid contained in rain-water, on limestone, is well known, and the effects of this weathering is perhaps as well shown at Birkrigg as anywhere, but it is on the surface of the rocks which are exposed to this action that we find the effects, and not on the sheltered portion; and as the exposed rocks vary in hardness, probably from metamorphosed fossils contained in them, the stones take many fantastic shapes, and are collected for artificial rockeries. But to return to the borings, the interior surface of these is smooth, except some very slight circular marking round the cell, suggestive of a grinding action; and that this action is quite recent is shown by the state of some of the holes, the lower portion, or that nearest the opening, being tinged slightly green by a microscopic vegetation, whilst the upper or last excavated portion is perfectly fresh and white, having a fine granular appearance very similar to what is given by washing the limestone with dilute acid and allowing it to dry. This variation in the appearance of the surface of the chambers has been noticed both by M. Bouchard and by Mr. Bonney. The action of the atmosphere, however, leaves a roughness and a quasi-columnar appearance, which at once distinguishes it from the surface of the borings, as is very evident when a boring has been fractured at the edge of the rock, and the section of it exposed to the action of rain, some cases of which occur on the edges of Fig. 1, where the effect of weather is strongly marked.

The next supposition is that they are the holes of *Pholades*, excavated before the elevation of the rock above the sea, and thus may be used as a proof and measure of such elevation; and this in reality is the principal *geological* interest connected with these holes. Against this theory Birkrigg is a strong case, for the burrows are in the underside of a nearly level rock, and bored upwards, which is contrary to the habit of the *Pholades*, as they bore downwards, and make their holes pyriform to fit their shells; but these at Birkrigg, as well as those in the Boulonnais, at Tenby, and at the Ormeshead, are of a great variety of shapes, and seem, in some cases, to have had several inhabitants at once. Nor are the holes at all similar (except at the opening) to those made by any of the *Pholades*.

Even supposing the holes might be similar to *Pholas* borings, it is scarcely possible to believe that thin and exposed ridges of limestone, like those in question, would not have been weathered and denuded so as to have destroyed every trace of such comparatively superficial apertures, during the many ages which must have passed since their elevation; that being probably anterior to the Glacial period, or, if since that period, they must have been denuded of the glacial drift or Boulder-clay then left on them without being themselves materially acted upon.

We may now consider the action of snails, which appear to abound wherever these borings occur, and which are very frequently found, alive or dead, in the holes. M. Constant Prévost, who, many years since, found excavations in the hard crystalline marble of Monte Pelegrino, near Palermo, did not hesitate to ascribe them to the *Helices* which he found in them, and most of the authors above alluded to mention the presence of snails, or their shells, in the holes; and although finding a snail in a hole certainly is no proof that it made the hole, still, when snails are repeatedly found in holes made in situations which they usually frequent, it is strongly suggestive of their agency; and when we have reason to believe that they have the power of making them, I cannot think we can be wrong in giving them the credit. At first it may excite surprise that a snail should have power to drill into a hard Crystalline Limestone Rock, but we do know that the Gasteropods are furnished with a lingual band of teeth which "can be used like a file for the abrasion of very hard substances. With them the limpet rasps the stony nullipore," and "the whelk bores holes in other shells."[1] M. Bouchard watched these excavations in the "Bois des Roches" for many years with great care, and from time to time measured their progress, which left in his mind no doubt of the fact that they were made by the snails; but assuming that to be so, the question suggested itself—How do they work upon the rock, mechanically or chemically, or by both means? M. Bouchard advocated the chemical theory, and has made observations on the mucus or slime which the snail leaves in its trail, and which he believed has corrosive action, although he could find no trace of any free acid in it. This action of the slime appears to me to be very doubtful, as there is no trace of any corrosive action on the polished surface of rock at Birkrigg, above alluded to, and which must have been repeatedly passed over by the snail in going to and from its hole. Miss Hodgson states (in the *Geologist*, vol. vii. p. 43) that she tried the fluid secreted by the snail when crawling, and that "when the animal is merely gliding along and not using the tongue, a little bubble of fluid is constantly, at short intervals, emitted from the mouth, which partially opens for the purpose. I have repeatedly saturated strips of litmus paper in this fluid, both at the head and all along the foot, but have entirely failed to detect any pink colouring denoting the presence of an acid." M. Bouchard, however, found that if he removed the snail whilst in the act of perforating the limestone, the exudation from its mouth did redden litmus paper, showing that the secretion was then acid. Professor Huxley states that the commonly called palate of the Mollusca, which he names the *odontophore*, "consists essentially of a cartilaginous strap which bears a long series of transversely disposed teeth. The ends of the strap are connected with muscles attached to the upper and lower surface of the hinder extremities of the cartilaginous cushions, and these muscles, by their alternate contractions, cause the toothed strap to work backwards and forwards over the end of the pulley formed by its anterior end. The strap consequently acts after the fashion of a chain-saw (or rather of a rasp) upon any substance to which it is applied. . . . . . Besides the chain-saw like motion of the strap, the odontophore may be capable of a licking or scraping motion as a whole."[1]

---

[1] Dr. S. P. Woodward; Manual of the Mollusca, p. 27.

From this it appears most probable that to the odontophore of the snail we must look for the tool by which this work is carried on, and, from the above observation of M. Bouchard, to all appearance with the aid of an acid which may possibly be secreted by the salivary glands, excited by the alternate action of the above strap, analogous to the action of mastication on our salivary glands; and although our saliva may not be acid, the effect of the action may be the same, though the secretions differ. In our case the acid necessary is secreted with the gastric fluid during digestion; in that of the snail the acid solvent would be secreted as required to assist the action on the limestone. But supposing these surmises to be incorrect, and that there is no chemical action, the mechanical effect of the file-like teeth would probably suffice for the purpose, though not so rapidly. The action of fine sand-paper on marble will illustrate this, as the odontophore acts in the same manner.

It has also been suggested that these holes were originally made by the *Pholas*, and that, after the elevation of the land, they were enlarged by snails; but I cannot see anything to justify the supposition, as, if it is admitted that snails could enlarge the holes and make fresh chambers in them, surely they must have power to commence them, and the action of the *Pholas* would be quite unnecessary. But a difference in the habits and nature of the Pholas and snail must be considered, which in itself appears fatal to the supposition of joint action. The burrows of the *Pholas* are described by Dr. S. P. Woodward[2] as vertical and quite symmetrical, whilst those in question are never either the one or the other. The *Pholas*, being aquatic and requiring water for breathing, makes its hole downwards, so as to retain some moisture when the tide recedes; whilst the snail, being air-breathing, always takes a reverse position; and any one who will examine an old wall when snails are hybernating will find them attached most frequently to the roof of a cavity with their shells downwards, sometimes on an upright part distant from the opening in the wall through which they enter; but I have never seen one on the floor of the cavity, or anywhere where water could accumulate: and it is precisely in accordance with this habit and in such shaded situations that these holes are found, and which are bored upwards for the same reasons. The same holes, therefore, would not be suitable for the aquatic and the air-breathing Molluscs: what would be life to the one would be death to the other.

---

[1] Elements of Comparative Anatomy, p. 36.

[2] Manual of the Mollusca, p. 327.

In conclusion, the fair inference to be drawn from the foregoing appears to be that the holes and chambers in question are not the work, even partially, of *Pholades*, or of any other marine Mollusc, and therefore are of no value as a testimony to any movement or elevation of the land. But, all the facts being considered, as well as the distribution of the holes in so many limestone districts where snails abound, at such various altitudes, and so far asunder, the position of the holes and their form agreeing with the habit of the Mollusc, it may reasonably be assumed that Dr. Buckland was correct in the conclusion he drew, in his paper published in 1841, that the holes were made by *Helices*—not, however, as M. Bouchard supposed, by the chemical action of the snail secretion alone, but by the mechanical rasping action of its odontophore, assisted, possibly, by an acid secretion from its mouth.

III.—Banded and Brecciated Concretions.

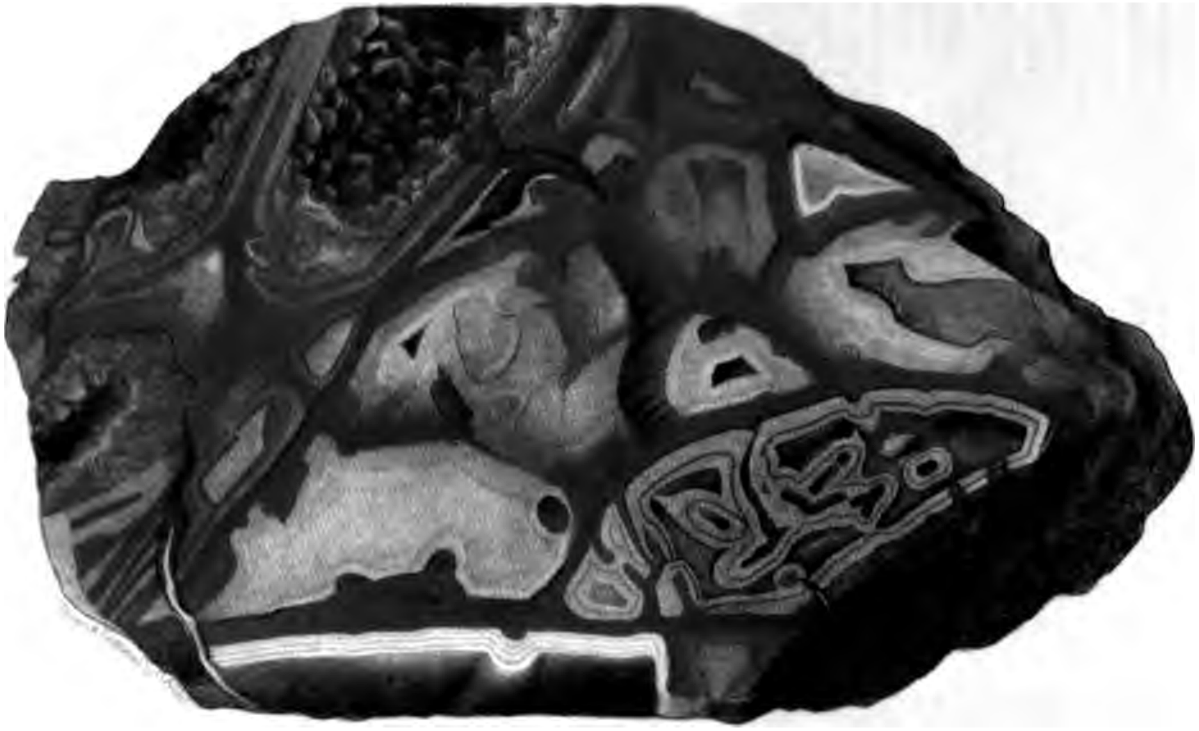
By John Ruskin, LL.D., F.G.S.

(PLATE II.)

(*Continued from the December* (1869) *Number, page* 534.)

We have now, I think, obtained sufficient evidence that the disposition of differently coloured or composed bands in agate is in most cases the result of crystalline segregation. We shall find, also, that the order of this segregation is constant under given conditions; and that, with fixed proportions of elements and fixed rate of cooling and drying, the agate will necessarily produce itself in a riband of a fixed succession or pattern of stripes: a spectrum of substances, which, if we had observed data enough, we might read like a spectrum of light; inferring, not the nature of the elements from its bars of colour, but the former conditions of solution from the bars of elements.

When the stone has been undisturbed, this riband or chord of its constituent elements will necessarily form quietly round it, either in its nest, or on its nucleus, with phases of level or vertical deposit under peculiar circumstances. But when the congelation has been disturbed, the chord of elements is broken up, and may then be traced here and there about the stone, forming where it may, and as

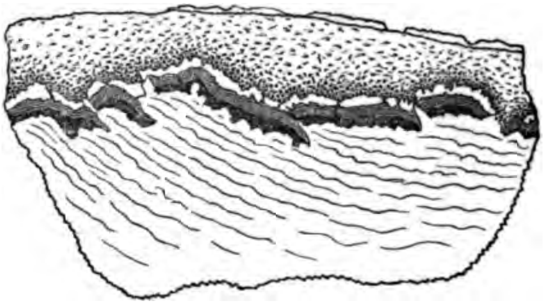


TRANSITION FROM MURAL TO INVOLUTE AGATE.

it can. For instance, Fig. 1 represents rudely a quartzose band formed at a junction of fluor with siliceous sandstone. The dotted space is the grit, the undulating lines stand for a coarse mass of compact fluor spar, vaguely crystalline in that direction.

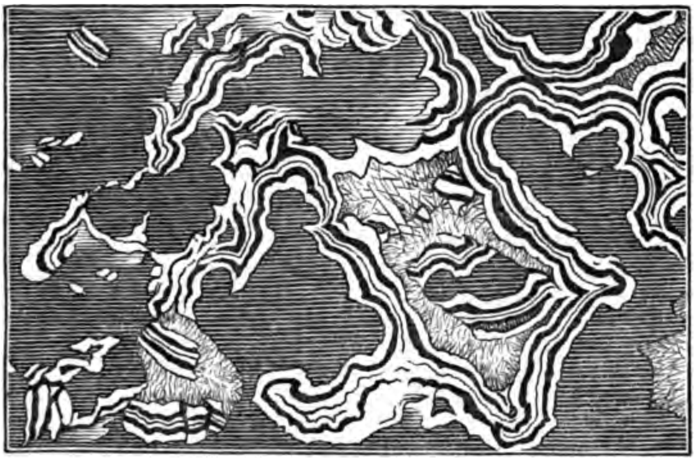
The faulting of the band is, I believe, entirely owing to fitfulness in the crystalline action; there is no trace of any kind of flaw or rent, either in the sandstone on one side, or fluor on the other.

Fig. 1.



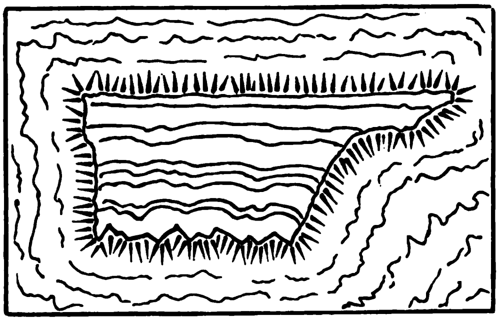
The composition of the band here, as in the hornstone (Geol. Mag. 1869, Dec., Fig. 1, p. 529), is of one series of elements only; but very often the chord is composed of a central band, with corresponding opposite series on its sides. Here, in Fig. 2, is a very simple case, in which the chord has a thin white central line, with first a dark and then a broader white one on each side. The entire chord is flung irregularly about the stone, sometimes in continuity for a few folds, sometimes in broken segments; but the outer white band has the power of detaching itself from the chord occasionally, and of expanding here and there into wider spaces.

Fig. 2.



And, as in Fig. 1, we have a deceptive semblance of consecutive faults, so here we have an equally deceptive mimicry of brecciation by violence. But the two apparently broken portions of the band, in the centre of its own loop, are simply detached crystalline formations of it in those places. Here, Fig. 3, is a single example of such an one from another stone, in which the enclosed banded segment is seen at once to be concurrent at its base with every undulation of the surrounding belt, though so trenchantly divided from it at the flanks.

Fig. 3.

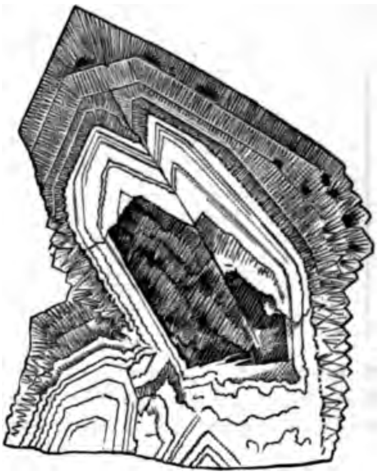


And here we have to note a further separation of our subject into two branches, or, rather, into two threads of mesh (for its classification, like most true natural ones, is not branched, but reticulated). When the bands form in several fragments in all directions, as in Fig. 2, we are conducted gradually to the most fantastic structures of abruptly brecciated agates. But when they are systematically affected by a consistent action of crystalline power, as in Fig. 1, we are conducted to the group I shall describe in the following paper under the name of involute agates (I carelessly used the word "conchoidal" for involute, in page 534), which seems to me, as far as I have any clue to their mysterious structure, to be chiefly owing to the action, in a partially fluid substance, of the great diagonal—or spiral?—force of silica. This diagonal power of, or in, quartz, is to me one of the most interesting phenomena in mineral nature, both in itself, and as one of a group of powers like it—wholly distinct from the crystalline ones, and acting with them, or dominant over them, at particular times and places, elsewhere and at other times remaining entirely passive.

Thus the growth of an ordinary quartz crystal depends on the regular imposition or secretion of parallel coats, which sometimes are capable afterwards of frank separation, forming "capped" quartz. But the flute-beak of Dauphiné is never capped. It is formed and wholly compacted under an oblique energy, which disciplines and guides together the hexagonal forces of the crystal. On the St. Gothard the same force, instead of terminating the crystals obliquely, unites them laterally, and leads them into long walls, warped into 'curves, sometimes like crowns or towers. Generally, when there is amianthus within crystals, the oblique force carries the filaments across the crystal diagonally; and it is very notable, as regards the time of secretion of these interior deposits, that while the iron oxides always arrange themselves in concurrence with the coats of the crystal, amianthus and rutile never do, but shoot clear through the whole body of it, if themselves long enough, and, if short, root themselves on an external plane, and shoot to the inside;

while the iron oxides root themselves on internal planes and shoot to the outside.

Fig. 4.



Here (Fig. 4) is an example which will at once illustrate the power of the oblique force, and this relation of the oxides.

It is the section of a singly terminated, and apparently, seen from the outside, an altogether single, crystal, one of a well-formed cluster, showing externally no signs of disturbance. They are all beautifully spotted with black iron oxide under a clear external coat, about one-seventh of an inch deep, which entirely covers them. These concretions of iron are represented in the woodcut accurately in section by the black spots; a minor series, not seen externally, is exposed by the section within the crystal, which is also shown by the section to be dual in the interior, separated into two parts by a perfectly straight line in the direction of its length, and nearly into two other parts by a jagged and broken one across it; all the interior beds being faulted by the oblique force, which acts,—in one direction softly, guiding, without breaking, one part of the white beds (opaque white in the stone) into an angle beyond the other,—and in another direction violently, causing jagged flaws across the beds. Within the white beds, and under the great flaw, the quartz becomes again dark-clear.

Now, all these arrangements of substance take place under laws which surely need more investigation than they have yet received,[1] being quite distinct from those which limit crystalline form, and bearing every semblance of a link between molecular and organic structure. For instance, pure crystalline force determines both gold and silver into cubes or octahedrons. So also it determines the diamond. But no force of aggregation supervenes to form branches or coils of diamonds; whereas an unexplained power, dominant over the crystalline one, extends the golden triangles into laminæ, and wreaths the cubes of silver into vermicular traceries. Agencies alike inexplicable twist the crystal of quartz like a piece of red-hot iron, and design the bands of agate into curves like those of a nautilus shell.

The transition from such coated crystals as that shown in Fig. 4, to these involute agates, may I think be traced without a break. The base of this stone is formed of smaller and less perfect crystals, which, cut transversely, present themselves in honeycomb-like groups, Fig. 5. Each of these cells is a little mural agate, with no spherical force disturbing it. When quartz disposed to such formation gets mixed with jasper, or with any other uncrystallizable rock, the cells become shapeless, and we get results such as those represented in Plate II. This stone there drawn shows the combination of angular cells with confusedly coiled ones, of which a close-set group is seen on the right, gathered together within broadly curved lines, which I think we shall be able to trace through succeeding examples, as they reduce themselves to the shell-like contours of true involute agate. On the other hand, in the centre of the stone, the less disciplined series of jasper veins, surrounding crystalline spaces, show the first origin of the groups of agate, which ultimately resemble a pebble breccia. I will endeavour in following papers to trace the two series through their gradual development.

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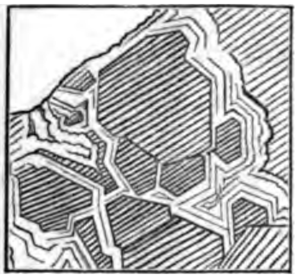
[1] I look with extreme interest to the result of the inquiries which Mr. W. Chandler Roberts has undertaken on the chemistry of silica. I have to thank him already for some most valuable information communicated to me in the course of last year, of which, however, I will venture no statement until he has made public his discoveries in such form as he may think proper.

Fig. 5.



IV.—On the Denudation of the Lake-district.

By J. Clifton Ward, F.G.S., Associate of the Royal School of Mines, of the Geological Survey of England and Wales.

An interesting Article by my colleague, Mr. C. E. De Rance, in the last number of this Magazine, upon "The Surface-Geology of the Lake-District," induces me to offer a few remarks in connection with the subject.

Being engaged in the Survey of part of this district, I am at present professionally tongue-tied as to details, but there are several *general* points connected with its ancient and present physical geography which have not seldom occurred to me during the short time I have been in the country.

1. The enormous amount of denudation that has taken place over the area in question, almost as much material having been taken away in the formation of the valleys as has been left to form the mountains.

2. The utter incompetency of marine action to form the present contour of the country, its complicated systems of valleys, its numerous lake-hollows.

3. The very great power of the atmosphere as a present working agent; the frequent storms, the deluges of rain, the almost constant wetting of the hill-tops, the sudden changes in temperature, the giant power of frost, the rushing of the wind up or down valleys and round corners.

4. The very vast period of time during which this agent must have been at work in order to produce such great results.

5. The varied conditions of climate which must have prevailed during this vast period of time.

With regard to the amount of denudation, there is probably no other area in England, with the exception of Wales, where anything like it has taken place. The reason of this seems to be that no other area, excepting Wales, has kept its head so much above water during many past geological ages. Dry land and sea-margins are the domains of denudation, ocean depths those of preservation.

If we go back to "Old Red" times, we find reason to suppose that an area of dry land then existed almost similar in size and situation to the present Lake-District. Around this land, formed of the elevated Silurian rocks, the Old Red deposits were formed, and upon it very probably glaciers found a home.

During the Carboniferous Period it seems not unlikely that the greater part, if not the whole of the Lake-district[1] subsided beneath the sea, and was covered up by deposits of that age.

Then followed a gradual upheaval and extensive marine denudation, by which most likely the old table-land was formed, traces of which may still be seen in the almost uniform heights of the mountain tops. From this time, however, up to the Glacial Period, there is no evidence of a depression of this area beneath the sea, and during this prodigiously long period, the atmosphere was busily at work cutting out the plain of marine denudation more or less into its present form.

This agent, however, must have worked at various times under very different circumstances, and with tools of very different form and degrees of power. Thus during the Permian Period frost, ice, and snow were most powerful; in Oolitic times these were abandoned, and tropical rainfalls and floods very possibly employed; succeeded again by ice in probably Middle Eocene, Upper Miocene, and Pleistocene times, with corresponding intervals of comparative warmth, when the milder but not less powerful tools were made use of.

In the midst of the Glacial Period, however, after the land had been well ice-covered, a somewhat considerable depression probably did occur, and the district was reduced to the condition of a group of icy islands. When re-elevation occurred, the glaciers still lingered on for a period, but at length gave way before the present milder order of things. It seems highly probable, however, that this district, both during depression and elevation, was so encased in ice that marine action could take no effect, and hence its comparative freedom from marine deposits and traces of coast-action at various levels.

It seems to me, then, that one must either be a 'marinist' and believe as one's creed that such a country as the Lake-district—perhaps the most denuded in England—received its sculptured form in Pre-Permian times through marine action, and ever since has been at a standstill as regards denudation, with the exception, perhaps, of the formation of some paltry ravine or evident stream-course which even marinists cannot get over; or be a sub-äerialist, and believe that in Pre-Permian times the sea rough-hewed a block of country which the atmosphere has ever since been carving into its now complex and beautiful form.

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[1] *Possibly* this old pre-Carboniferous land was a Lake-district; the "Old Red" Glaciers may have scooped out "Old Red" Lakes.

The difference between a marinist and a sub-äerialist seems to be this: the former believes in the great power of the sea and in little or no other power besides; the latter in the great power of the sea to rough-hew, and likewise in the great power of the atmosphere to sculpture.

To touch briefly upon one or two points of surface-geology. From what I have at present seen of the Lake-district I certainly should not have come to the conclusion that the "steep escarpments generally face the east, south-east, or north-east;"[1] and since the general dip of the Green-slate Series is to the south-east, one would expect rather the contrary to take place. That dip-slopes to the east or south-east are not more frequent in this case is due, I think, to the almost uniform hardness of these so-called Green-slate beds; since, not unfrequently, where a well stratified ash-bed is found amidst the lava flows, it gives rise, on a small scale, to a well-marked dip-slope on the east or south-east and a corresponding escarpment looking west or north-west.

Among other things, Mr. De Rance speaks of the disbelief of some people in the much-excavating power of streams and rivers in the Lake-district.[2] Now it seems probable that the *special* province of the rivers is not so much to excavate—though that is often done to a very considerable extent—as to scavenger, to bear away and roll to ever lower and lower levels material detached by the action of the weather from the hills on either side. And how anyone can walk along a steep Cumberland mountain-side, with the loose stones slipping from under his feet at every step, with overhanging crags, with many masses already half slipping, and many more now lying at the valley bottom, or lodged on some projecting ledge,—some dingy and moss-grown, others but freshly fallen; or can even watch how the sheep, along their narrow self-made paths, are constantly helping to lower the loosened material, and yet shut his eyes to the mighty but slow denudation now taking place, is a wonder.

Of the filling up of lakes by stream and river-borne material there seems to be abundant evidence. Keswick Lake and Bassenthwaite were almost certainly once connected — and even now occasionally are so in floods—yet they are at present separated by more than three square miles of alluvium. In a similar way Buttermere and Crummock Water are separated. Thirlmere has been filled up at its head for at least a mile. There is many an old lake too, now represented solely by a rich alluvial tract. Such deposits as these, it must be remembered, represent only a fraction of the denudation that has taken place since the Glacial Period, much of the denuded material, as Mr. De Rance observes, having found its way to the sea. That such alluvial deposits as those named above have been formed since the Glacial Period, is evident by the way in which they lap round and cover up ice-smoothed and ice-scratched bosses of rock; and if, in this comparatively short time, such denudation has taken place, what amount of material may not have been removed since Permian times?

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[1] Mackintosh, Geol. Mag., Vol. II.

[2] Geol. Mag., Nov. p. 493.

V.—Observations on the Sequence of the Glacial Beds.

By S. V. Wood, Jun., F.G.S.

THE Article in this Magazine by Prof. Harkness, "*On the Middle Pleistocene Deposits of Britain*,"[1] will, I trust, call the attention of geologists more prominently to the fact that a break occurred in the Glacial period, wherein the formation of Boulder-clay was arrested for a considerable interval, and an extensive formation of sands and gravels spread out, accompanied, apparently, by some amelioration of the temperature of the sea. Nevertheless, there are several things pressed by Prof. Harkness into his case as to which a word of caution, and even of dissent, seems necessary.

I would preface these remarks by venturing to demur to any attempt to determine the succession of the Glacial and Post-glacial marine series by the evidence of organic remains *alone*, and to urge that this kind of evidence, unless kept strictly subordinate to that afforded by the physical relations of the beds, as well as by mapping, or other close method of pursuing them, is more likely to mislead than assist, in consequence of almost all the shells belonging to species now existing. There are, however, two marked facts connected with this kind of evidence which I think may be relied upon. These are: 1st, that the presence of *Tellina Balthica* (*solidula*) is a test that the bed yielding it belongs to the *Glacial* or *Post-glacial* formations, and not to any of the Crag series;[2] and 2ndly, that the absence of *Tellina obliqua* affords a presumption[3] that the bed—at least any English bed—from which it is absent is of *Post-glacial* age, meaning by such term that it belongs to the period during which the land was rising from the great Glacial submergence, or to the time which followed emergence. With these two exceptions, I would urge—and as much in depreciation of my own inferences as those of others—that any conclusions sought to be deduced from a list of Mollusca should be received with large savings on various accounts.

With that premise, I venture to doubt whether Prof. Harkness has not included in his extensive sweep of identification with the Wexford Gravels some beds that can hardly by any possibility be identical.

How far the identity he seeks to establish between the gravels of

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[1] Vol. vi., p. 543.

[2] As this shell has so long, but erroneously, been included in lists of Crag shells, it may be useful if I add that it is *not* given as a shell of the Belgian Crag by M. Nyst.

[3] Subject, however, to the doubt expressed further on in this paper.

Wexford and those occurring in the basin of the Severn, and between both of these and the Middle Glacial of the East of England, may be well founded, I venture no further opinion than that the fauna of the Severn gravels differs materially from that of the East Anglian formation,[1] and that these gravels have not yet been described as overlain by Boulder-clay.

No mention, either, is made by him of *Tellina obliqua* among the Wexford shells; nor is that shell among those given from the Severn gravels. He is also silent as to *Tellina calcarea* (*proxima or lata*) being among the Wexford fossils—a shell never absent from any of the Glacial series, or even from what I venture to think may be among the oldest of the Post-glacial, viz., Moel Tryfaen, though this shell is among those enumerated from the Severn basin. Nevertheless, I ought to mention that I have traced the Middle Glacial, from its great expansion in East Anglia along a narrow and tortuous belt across the more central counties, to a part where, around Rugby, it is cut through by valleys whose drainage belongs to that system which falls into the Severn at Tewkesbury.

With respect, however, to any identity between the Middle Glacial of East Anglia and the gravels of Moel Tryfaen and the Macclesfield neighbourhood, the case seems to me to admit of more positive determination, and that determination to be adverse to such identity.

To make the case intelligible, I place the beds of the Eastern side of England in that (descending) order which I have for some time, in co-operation with the Rev. J. L. Rome and Mr. F. W. Harmer, been endeavouring to establish.[2]

Newer Post-glacial	*a.* Ordinary river-gravels and brick-earths without *Cyrena fluminalis*—a series probably extending over considerable time.	
Older Post-glacial	*b.* Hessle (Boulder) clay. *c.* Hessle gravel (Kelsea Hill bed) with *Cyrena fluminalis* and the Nar valley beds. *d.* Gravels mostly occurring on plateaux and on hills;—sporadic accumulations of small extent and at all levels, and connected with the denudation of the Glacial beds during their emergence from the great depression.	

Here, or more precisely between *c* and *e*, intervenes the great denudation and principal unconformity.

Upper Glacial.	*e.* The purple (Boulder) clay of Yorkshire *without* chalk, passing down into *e′.* The purple (Boulder) clay *with* chalk, and containing the Bridlington shell-bed.	Both of these have intercalated beds of sand.
	e″. The great chalky (Boulder) clay.	
Middle Glacial.	*f.* The Middle Glacial sand and gravel, with chalky Boulder-clay in some, though very rare, instances either in it or at its base.	

A marked unconformity and a considerable denudation of the beds *g* and *h* here intervenes.

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[1] The list of Mr. Maw's Severn Gravel shells, identified by Mr. Jeffreys, contains thirty-five forms of Mollusca, all of them living. Eight of these (inclusive of *Tellina Balthica*) are unknown to the Crag, and of such eight two only range into the Arctic seas. As to the East Anglian shells, see post.

[2] For this, see principally the following papers, viz.:— S. V. Wood, jun. and J. L. Rome, Quart. Journ. Geol. Soc., vol. xxiv. p. 146. S. V. Wood, jun. and F. W. Harmer (Brit. Assoc., 1868), Geol. Mag., Vol. V. p. 452. S. V. Wood, jun., in a paper read before the Geol. Soc. on Dec. 8, 1869.

Lower Glacial.	*g.* The Contorted Drift of Norfolk and its marl representative. Between this and *h* there is a very conspicuous denudation and unconformity visible in Hasboro' cliff; but it seems local, and is very different in character and extent to the other unconformities and denudations mentioned.
	h. The Cromer Till and the Pebbly sand of Norfolk and Suffolk.

A marked unconformity and denudation here again occurs; the interval of which is, as I *now* think, marked by the Cromer Forest and its associated fresh-water beds.

Upper Crag.	*i.* The Chillesford clay and sand, forming the upper or marine portion of the Norwich Crag.
	k. The Red Crag, and the lower or fluviomarine portion of the Norwich Crag.

In addition to the above may be added a class of mound-like gravels in the mountainous parts of Britain, due to the action of the Glaciers occupying the mountain valleys during the *Post-glacial* period[1], and which probably extend over the greater part (and, in the higher latitudes of Britain, indeed of the whole) of the period embraced by the deposits *a* to *d* inclusive, but to which I shall have no occasion to allude in this paper.

Subsequent to the latest of the above series (*a*) the land has undergone a depression by which the forests occurring under the coast silt and alluvium were buried; the greatest extent of this depression of which we have evidence being that of 56 feet below high-water mark at Grimsby.

The Gravel formation, extending from the neighbourhood of Reading to that of Canterbury, and of which a part occupies the Thames valley between Pangbourne, in Berks., and Fobbing, in Essex, is omitted from this table for the sake of simplicity. I regard it and its associated beds with *Cyrena fluminalis* as coeval with the beds *b* and *c*.

Between *e* and *c* there occurred the great emergence of the land from the climax of the Glacial submergence—a submergence that we know, from the dispersion of the Shap granite blocks, to have amounted to 1,400 feet at the least. This emergence was accompanied by a very great denudation, that is feebly marked by the beds *d*, forming, necessarily, the terms of a long series, of which the highest are the oldest, and the lowest the newest; all those occurring in East Anglia, where the highest elevation does not exceed 550 feet, belonging to the latter class. It was not until the emergence had reached a point corresponding nearly to the existing level that the beds *c* were formed, because we find in them at Kelsea the river-shell *Cyrena fluminalis* associated with a littoral marine fauna, which proves that low-lying Holderness had, at this time, become in close contiguity to land. The re-submergence giving rise to the clay *b*, which overlies *c*, was not only insignificant in amount when compared with that great submergence in which the *Glacial* period culminated, but was also local in its extent; the general lay of the clay *b* indicating that its maximum submergence—which could scarcely have exceeded 350 or 400 feet anywhere in Yorkshire, if indeed it amounted to so much—died off to nothing towards southern

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[1] Different altogether to the enveloping Glacier, or ice sheet of the *Glacial*, or subsidence period referred to in the latter part of this paper.

Lincolnshire. This limited and localised *re*-submergence, it will be observed, was not only posterior to and unconnected with the great *Glacial* submergence, but seems to have been confined to the more Northern part of England.[1] What length of time was involved in the progress of this great and original emergence, I will not venture to estimate; but it can scarcely have been otherwise than considerable; and it is one which, by assigning to it certain fossiliferous gravels, may, I think, afford us an exit from many difficulties.

We are naturally too apt to estimate the duration of Geological time by the amount of deposit formed in any period, whereas probably the longest lapses have been those of which we have no representation, in the shape of deposits, in this country. As Mr. Darwin has said, it is during submergence that deposits accumulate; while during emergence their destruction is the principal thing that takes place, such accumulations as do form at this time being of limited extent and sporadic in their distribution.

Adding to the time thus occupied in this great emergence and denudation that which, subsequently to the North-East of England having completely emerged, was occupied in its partial re-submergence and recovery therefrom, and to this again adding the period during which our river-gravels and brick-earths, without *Cyrena fluminalis*, were accumulating—a period in which very considerable changes in the mammalian inhabitants of this country took place—and we shall, I think, find ample scope for supposing that the Post-glacial period (*as previously defined*) may have equalled, if even it did not exceed, in duration the Glacial.

Let us now examine the features which the Mollusca yet obtained from the various beds present. The pebbly sands of Belaugh and Rackheath, in Norfolk, to which Prof. Harkness refers as underlying the Lower Boulder-clay of that county,[2] are those from which the Lower Glacial shells have been procured by Mr. Harmer and myself. They have yielded thirty-five forms of Mollusca. This sand, though continuous with the pebbly sand underlying and interbedded with the Till, along the Cromer coast, and yielding similar shells, is regarded by Mr. Harmer and myself, from the way in which the Till disappears southwards towards Norwich, as the sands thicken, and from other circumstances, as representing not merely the sand underlying and interbedded with the base of the Till along the coast, but also the Till itself, which contains sheets of chalk, stripped by land-ice from the old Norfolk floor. Such shells and fragments as the Till and the Contorted drift, *g* (which overlies the Till where that is present, and, where it is not, overlies the pebbly sands), have yielded, are all forms which occur in the Belaugh and Rackheath sands; and we feel no hesitation whatever in regarding the fauna obtained from the sands at these localities, and at Weybourne and Runton, as being that which lived during the accumulation of the beds *g* and *h*, forming the Lower Glacial of the above table. Now, with the exception of *Tellina Balthica* (*solidula*), the test shell of the Glacial and Post-glacial series, and of a new species of the freshwater shell *Paludina*, all the forms thus obtained belong to the Upper Crag.

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[1] How far it may have extended into Scotland I know not; but, while the central parts of England do not appear to have participated in this partial re-submergence, it is important to observe that the evidence seems to me clear that all the South of England, as far as the Northern limit of the Thames gravel formation, except the higher parts of the Wealden dome, had not, at the time of which I am speaking, emerged from the original Glacial depression, but was being denuded under the influence of those submarine disturbances which began by breaking up the Thames gravel formation, and terminated with the elevation and complete denudation of the Weald valley. It seems reasonable to suppose that the partial re-submergence of the North-East of England was the result of this elevatory activity in the South, by way of counterpoise, and that during it the *Cyrena fluminalis* occurring in the Thames gravel formation, and in the bed *c*, and not known as a Glacial shell, died out in this country.

[2] This term, "Lower Boulder-clay," is very objectionable and illusory; for not only are there several Boulder-clays, but the so-called Lower Boulder-clay of Cromer (part of *h*) is not the bed called Lower Boulder-clay at Norwich, which is the contorted drift, *g*, that overlies *h* on the Cromer coast. On the other hand, if I am right in my deductions, the bed, e'', which is the uppermost in East Anglia, is the lowest Boulder-clay in Yorkshire; the bed *b*, which I regard as no part of the Glacial series at all, being the uppermost Boulder-clay of this county.

The Middle Glacial shells now obtained by me, with the assistance of Mr. Dowson (of Geldeston), from Hopton Cliff, where this deposit actually occurs between *g* and e''—supplemented by some others from the Bradwell Cutting, two miles inland of the cliff, where the deposit is also capped by e'', obtained by Mr. Rose, and identified for him by Mr. Jeffreys—amount in number to thirty. These also, with the sole exception of *Tellina Balthica*, are Upper Crag shells; nineteen of them also occur in the pebbly sands (*h*).

So far, therefore, as the evidence yet obtained goes, not a single marine mollusc, with the exception of *Tellina Balthica*, had, from the period of the Upper Crag down to the close of the Middle Glacial formation, established itself in the East of England, though a number seem to have disappeared.

Throughout this time, and also throughout the formation of the bed e'', the most extensive of the series, the material of which the beds are formed proves that the Chalk was the largest—indeed, in many places, the almost exclusive—contributor, by its icy degradation, to their formation.

At Bridlington, however, just at the horizon (e'), in the series where the supply of Chalk *débris* begins to fall off, and when, we may infer, most of the Chalk itself had, by the progress of the submergence, passed out of the reach of the icy degradation, we get a very marked and different fauna—different not only in the fact of its containing many shells not known to the Crag, but in the circumstance that all of these introductions are of an Arctic character. Out of sixty-seven Bridlington forms there are, inclusive of *Tellina Balthica*, twenty-two not known to the Upper Crag; the greater part of these being exclusively arctic forms, and the rest (with the exception of two, or perhaps three, not known living) British shells, extending, with one exception, into the truly Arctic seas.

Throughout all the series up to this point, the now extinct shell, *Tellina obliqua*, lived. In the Coralline Crag it occurs. In the Red and Fluvio-marine Crag, in the Chillesford bed, and in the Lower Glacial it swarms. In the Middle Glacial it appears to be not uncommon, and at Bridlington it seems, from Dr. Woodward's list, to have occurred.

Let us now contrast with these features those afforded by the fauna from Moel Tryfaen, and from the Macclesfield sands, given by Mr. Darbishire,[1] and that from Kelsea Hill (bed *c*), given by Messrs. Prestwich and Jeffreys.[2]

Mr. Darbishire, grouping Moel Tryfaen and Macclesfield together, enumerated seventy forms of Marine Mollusca, among which are no less than seventeen or eighteen not known to the Upper Crag, of which only six are Arctic shells; and these (unlike the principal part of the Bridlington introductions, which are exclusively Arctic) are British forms extending into Arctic seas. The rest of the seventeen or eighteen are British and Southern. The six British and Arctic forms, however, do occur at Bridlington.

Of the forty forms (exclusive of the fresh-water *Cyrena*, but inclusive of the sinistral variety of *Fusus antiquus* as a separate form and all marine) given by Messrs. Prestwich and Jeffreys from Kelsea Hill, there are six that do not occur in the Crag, only one of which, the never-failing *Tellina Balthica*, is British and Arctic, the remaining five being British and Southern; all are living forms, and there is little, indeed nothing, in the group of shells as a whole that points to any affinity between them and the Bridlington fauna. Comparing it with Mr. Darbishire's list, there also appears an equal want of such a reasonable identity as would justify its reference to the epoch, whatever it be, marked by Mr. Darbishire's list, besides the indication, afforded by the occurrence in profusion of *Cyrena fluminalis*, of how shallow and estuarine must have been the place of its occurrence, while the exclusively marine fauna of Mr. Darbishire's list occurs at elevations reaching to 1350 feet above Kelsea Hill. Out of the seventy of Mr. Darbishire's list thirty-nine are not known at Kelsea, while out of the forty Kelsea shells of the list of Messrs. Prestwich and Jeffreys there are (exclusive of the *Cyrena*) nine not in Mr. Darbishire's list.

In none of these lists does the name of *Tellina obliqua* appear; and were it not for an imperfect specimen I found at Kelsea, that resembles this shell (but which may nevertheless be, and I think is, only a large and broken *T. Balthica*), I should have had no hesitation in saying that *Tellina obliqua* seems to have died out between the period of Bridlington and that of Moel Tryfaen.

In the next number, I shall endeavour to show how the physical evidence accords with that deduced from the organic remains.

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[1] Geol. Mag., Vol. II., p. 298. [2] Quart. Journ. Geol. Soc., vol. xvii., p. 448.

(*To be concluded in our next number.*)

VI.—SOME REMARKS ON THE FORMATION OF THE CHESIL BANK.

By THOMAS CODRINGTON, F.G.S.

THE Paper "On the Formation of the Chesil Bank," which appeared in the GEOLOGICAL MAGAZINE for October last, is prefaced by a statement that the authors (Messrs. Bristow and Whitaker) do not propose to enter into the question of the way in which the shingle was heaped up. But the way in which the shingle was heaped up is intimately connected both with the formation of the Chesil Bank and with its position in advance of the shore line, and, if rightly understood, any speculations on the waste of the coast behind the bank by sub-aerial denudation are superfluous.

The subject is fully gone into in Mr. Coode's paper "On the Chesil Bank" (Minutes of Proceedings Inst. Civil Engineers, 1853), and in the discussion which follows it, and the action of the sea in throwing up beach is one upon which those who have paid attention to the subject are pretty well agreed.

The origin of the Chesil and similar shingle banks is due entirely to the heaping-up action of waves breaking when they reach a depth of water about equal to their own height, and when a deep sea wave comes suddenly into shallow water, whether it be close in shore, or over a shoal or bank, shingle will be thrown up, if present. With this action tidal currents and eddies have nothing to do.

The authors of the paper endeavour to draw a distinction between the Chesil Bank and other shingle banks, but there is no essential difference. The Chesil Bank is undoubtedly the largest and most remarkable, but the Orfordness shingle bank rivals it in length. The latter is separated from the shore for ten miles, and it is a matter of history that it has increased in length five miles in three centuries. The growth of other similar banks has been observed, and a small but instructive example is furnished by the shingle bank now forming across the mouth of Christchurch Harbour.

About twenty years ago the working of ironstone in the Bracklesham beds of Hengistbury Head was commenced, and some large blocks which had before fallen from the cliff on to the foreshore were removed. The result has been that an accumulation of beach, derived from the gravel capping the cliffs to the westward, which had previously only travelled round the headland in small quantities, was let loose, and a shingle bank a mile in length has already formed, and is now growing at the rate of about forty yards a year, with every prospect of continuing to do so until the accumulation of beach to the westward has been reduced and the balance restored, or until proper measures are taken to stop the travel of the beach round Hengistbury Head.

At the Chesil Bank all the conditions exist for the formation of an isolated bank. There is unusually deep water close in shore, so that the Atlantic waves come in with full force, and under the shingle there is a bank of clay at about the level of low water. Before Mr. Coode had proved its existence at several points by boring, the Astronomer Royal had suggested that a bank or a shoal, enough to [illegible] the sea break, must be the determining cause of the line of the Chesil Bank; and Gough, in his additions to Camden (1789), mentions the base of black clay left exposed when the sea breached the bank and swept away the shingle. All the old accounts of the Chesil Bank speak of its being broken through as if it were not an unfrequent event, whereas it has not happened more than once, if at all, in the present century. There is also reason to believe that its height is now greater, and it has probably increased in size down to the present time, its formation being the result of the present contour of the coast line of the West Bay.

The source of the materials of the bank is unquestionably the coast between Sidmouth and Lyme Regis, to the east of which are Lias cliffs, which are being so rapidly destroyed by the action of the sea, that it is easy to imagine that at no distant time the coast line at that point advanced enough to stop the travel of the shingle. As the removal of a few large blocks from the shore at Hengistbury Head set the beach in motion to form the bank off Christchurch Harbour, so the wasting of the Lias cliffs near Charmouth and Lyme may be conceived to have removed the obstacle to the travelling of a large accumulation of shingle, which, moving eastwards under the action of the prevailing winds, was ultimately thrown up to form the Chesil Bank.

While the commonly received explanation of the formation of the Chesil Bank is quite sufficient, the theory put forward by the authors appears to have no facts to support it. Stress is laid on the supposed circumstance that where there are no streams the beach is not separated from the land, and that where there are streams it is separated; but this is not really the case. A stream flows down from the west side of St. Catharine's Hill, and turns sharply to the east on reaching the bank, on the inner side of which it flows for about half a mile before reaching the head of the Fleet. It cannot be supposed that the end of the Fleet has been excavated by this stream after it has flowed through meadows for half a mile; and the next stream (that from Abbotsbury) enters the Fleet about a quarter of a mile below its upper end. The hollow in which the Fleet lies extends for more than half a mile beyond the latter, the bank rising some twenty feet above the land inside, and sending out spurs which were doubtless thrown up as "fulls" of beach at an early stage of the growth of the bank.

The Fleet is almost stagnant; it is only at high spring tides that any variation of level takes place at the upper end, so that tidal action cannot have aided in its formation. The largest stream flowing into it is less than two miles long, and discharges, according to Mr. Coode, but 80 cubic feet per minute. The tendency of this and the other streams is to fill up the Fleet rather than to excavate it. Deposits of mud line both sides, particularly at the mouths of the streams, which are in fact small deltas of mud with no defined water-courses.

Lastly, if no real distinction can be drawn between the Chesil Bank and other similar shingle banks, the theory falls to the ground, for it cannot be said that the isolation of the Orfordness bank, Hurst bank, and many others that might be named, is due to the cause advocated by the authors of the paper.

VII.—TERRACES ON INLAND SLOPES.—REPLY TO G. POULETT SCROPE, ESQ.

By D. MACKINTOSH, F.G.S.

IN the article on Terraces in your last number, Mr. G. Poulett Scrope evidently did not intend writing in a style that would bear being minutely criticized, or he was not sufficiently particular in quoting from my work and representing my present views. As it stands, a reader of Mr. Scrope's article would receive impressions very different from those which a perusal of my chapter on Raised Beaches and Inland Terraces would leave on his mind. Such being the case, I am sure Mr. Scrope will pardon me if I make a few remarks in self-vindication.

1. The sentence quoted by Mr. Scrope in connection with Brent Knoll, is applied in my work to "terraces of erosion" (not "marine terraces of erosion") near Glastonbury.

2. While expressing an opinion that the Twyford terraces have been formed by oceanic currents or waves, I have added, "unless indeed we have recourse to the idea of a ponderous body of land ice moving down the valley, and scooping out large grooves in the sides of the chalk hills."

3. Instead of admitting that *some* of the terraces *may* have been formed by man, I have used the words "many" and "were." I have, however, opposed the idea of *all* or even the greater part of the terraces being artificial. Mr. Scrope has not quoted my principal objections to this idea, some of which run as follows:—

"A large proportion of these terraces are *longitudinally* inclined to such a degree as to render the 'descent of silt' theory untenable. Those very characteristics which at first seem to render it improbable that many of the terraces were once sea-margins, tell with equal force against their having been formed by man. Their irregularity is often bewildering, and yet they graduate into the more general form of the ground, and, in most cases, *conform in longitudinal inclination to the summit contours* of the slopes on which they occur, so as to suggest a natural rather than an artificial cause. . . . . [If these terraces were made in the middle ages, and cultivated by different tenants, each of whom worked a particular terrace, how is it that we have no record of such a custom? . . . . the immense numbers of sheep grazed in the middle ages, and the consequent value of down land, must in a very great measure have prevented its being cultivated.—MR. BAIGENT, of Winchester.] . . . . On the shores of the Menai Strait, and the desiccated branch of it which runs from Port Dinorwic to Bangor, the slopes of marine drift are varied by small irregular terraces not distinguishable in form from those of many parts of the chalk districts. . . . The shores of Morecambe Bay, from a few feet above the sea level to at least 600 feet, are in many places marked by both terraces of deposition and erosion. Those which occur at high levels, on ground which could never have been cultivated, as on the west side of Hampsfell, are chiefly terraces of erosion. In this district, as elsewhere, ridges have been artificially formed as boundaries between fields, but they are quite distinct from the terraces under consideration."—I might have added to the above natural terraces, thousands on the northern slopes of the Grampians extending down to the shores of the Moray Firth, etc., etc.

4. Instead of having examined no terraces, ***no not one***, and found rounded pebbles, etc., I have examined the composition of many, and in the chapter of my work under notice I have stated that the Stockbridge terraces are covered with a reddish loam, mixed with whole or fractured flints, and a considerable proportion of extra-rounded flint pebbles. Yet I have not asserted the marine origin of these terraces, though I believe (with the author of *Frost and Fire*) that they are "sea-work." I have likewise stated that one of the Llangollen terraces, as revealed by a road-cutting, consists of "a terrace of erosion covered by rounded stones, imbedded in clay and earth." I may add that the Llangollen terraces are more or less covered with an extension of the marine drift of North Wales. I would not have mentioned the apparent refuse of decayed shells in this drift, were it not that Mr. Darwin long ago believed that a similar substance found in drift near Shrewsbury indicated the former presence of sea-shells.

5. Mr. Scrope is evidently not serious when he asserts that one of the Llangollen terraces is *close to the railway station*, and presumes that I examined it while the train was stopping. The terrace in question is between a mile and a half and two miles from the nearest station, namely, Llantysilio; and I may be allowed to state that I am not in the habit of paying hasty or railway visits to geological phenomena.

6. The discovery of sea-shells in terraces is not an indispensable proof of their marine origin, as undoubted marine drift, in which no sea-shells have yet been met with, may be found extending over whole counties.

In conclusion, I would state that in the GEOLOGICAL MAGAZINE, nearly four years ago, I inadvertently used the word "raised beaches" instead of raised coast-lines, tidal terraces, or current marks. In my recent work I have not applied the term "raised beaches" to the terraces of the chalk-downs, but have written about them in a very cautious manner, merely expressing opinions, and leaving the question of their origin in a great measure undecided. Neither have I, in the above work, exclusively advocated "marine denudation," but endeavoured to do justice to all parties. The power of fresh-water streams, frost, and ice, I have fully acknowledged (see for instance *Recent Atmospheric Action in Snowdonia*), though I have regarded them more as destroyers than originators of the more typical features of the earth's surface.

NOTICES OF MEMOIRS.

SIR,—The kindness of Dr. Carl Jelinek, the Editor of the Austrian Meteorological Society's Journal, has enabled me to place at your service the accompanying woodcuts, in illustration of the subjoined translation, which you may, perhaps, think of sufficient interest to find a place in the GEOLOGICAL MAGAZINE.

ROBERT H. SCOTT.

METEOROLOGICAL OFFICE, 116, VICTORIA-STREET, WESTMINSTER, S.W.
December 8, 1869.

I.—ON SOME REMARKABLE FORMS OF HAILSTONES RECENTLY OBSERVED IN GEORGIA.

[Extract from a letter from Staatsrath Abich to Chevalier W. von Haidinger. From the Journal of the Austrian Meteorological Society, vol. iv., p. 417.]

I take this opportunity of giving you a preliminary notice of two hailstorms, of both of which I was fortunate enough to be a witness. The phenomena were of so unusual a character that they are well worthy of a full and precise account.

They took place within fourteen days of each other, the first on the 27th May last, at 3 P.M., the second on the 9th June, at 6 P.M. The localities were not far asunder, being both in the neighbourhood of Tiflis, near Beloi Kliutsch. The morphological characters of the hailstones, which were very large, as much as sixty or seventy millimetres in diameter, were as remarkable as they were dissimilar. On the first occasion they were oblate spheroids, resembling Mandarin oranges, while their structure seemed almost organic. On the second there was a fall of actual ice crystals, an occurrence which has never before been noticed, at least, as far as I could discover from the literature within my reach. The stones were not mere lumps, exhibiting indistinct crystalline forms, but spheroidal bodies of definite crystalline structure, overgrown along the plane of the major axis by a series of clear crystals exhibiting various combinations belonging to the hexagonal system. The commonest forms were those which occur in calcite and specular iron. Of the former type, by far the most abundant were combinations of the scalenohedron, with rhombohedral faces; crystals of fifteen to twenty millimetres in height, and corresponding thickness, prettily grouped with combinations of the prism and obtuse rhombohedra. The terminal plane was also occasionally noticeable. Some which fell at the beginning of the storm were flat, tabular, crystalline masses, thirty to forty millimetres in diameter, resembling the so-called "eisen-rose," which occurs at St. Gotthardt.

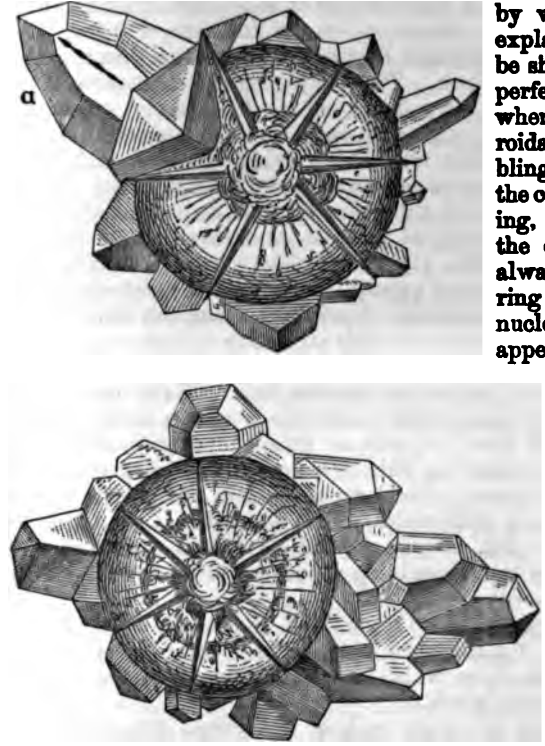
The stones, when picked up quite fresh, showed sharp edges, with faces which were for the most part slightly curved like those of diamond; however, those which I took to belong to the scalenohedron were perfectly plane.

I was in the open air when each of the storms began, and was able to gain shelter before I received any injury. This was fortunate, for the damage done, even to large trees, was very serious.

I reached home in a quarter of an hour, and found a pail full of the largest stones, which had been collected as soon as the first fright had passed over. My house was not much damaged. I sat down at once and drew ten of these remarkable forms, which had scarcely undergone any alteration.

I have often thought over our conversations about hail, and I see that if I now applied all the theories which have ever been broached to the facts which have come under my own notice, not a single one of them will give me any light towards their explanation. I would ask how such a regular growth of crystalline masses, reminding us in their character of the drusy crystals of calcite from Andreasberg, can be reconciled with the violent atmospheric commotion which we suppose to accompany the formation of hail. We say *in naturâ nihil fit per saltus,* and I believe it. The growing crystalline mass must have been suspended for a long time in a very cold stratum of aqueous vapour before it reached the earth.

[The two subjoined cuts are copied as closely as possible from the original drawings.]



Actual representations (of the natural size) of two of the Hailstones which fell in Georgia on the 9th June, 1869, drawn at the time by Staatsrath Abich.

I would only add, by way of a hint, to explain what cannot be shown by such imperfect drawings, that where the flat spheroidal forms, resembling specular iron, in the centre of the drawing, exhibit shading, the crystals were not always opaque. The ring surrounding the nucleus had a milky appearance, owing to small air bubbles, as had the nucleus itself in most instances. Many of them, however, had a clear nucleus. This could easily be seen next morning, when the stones had all melted down to cakes of about an inch in diameter, occasionally taking the shape of a regular hexagon. The milky ring round the central point was clearly distinguishable as a sort of fibrous web composed of the finest air cavities traversed by threadlike pores. In some cases there was no ring, and the nucleus was semi-opaque.

The shading round the border of the large circle is only intended to mark the smooth spheroidal form of the central mass. The actual crystals were attached parasitically to its edge, or else inserted in a sort of socket, as I found when the stones thawed down. *(See a, Fig. 1.)*

All the stones contained fine air pores, pear-shaped or worm-like, running from the centre to the circumference. The drawings are as near as possible natural size.

II.—DESCRIPTION OF *CONCHOPOMA GADIFORME*, A NEW GENUS FROM THE PERMIAN OF LEBACH, ETC.

By Professor KNER, of Vienna. Abstracted by Dr. CHR. LÜTKEN.

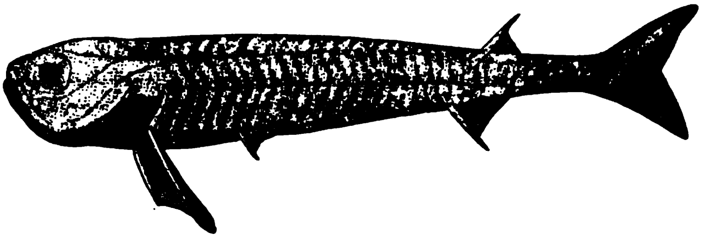
[Kner: Ueber *Conchopoma gadiforme*, n.g., und *Acanthodes* aus dem Rothliegenden (der untern Dyas) von Lebach bei Saarbrücken in Rheinpreussen. Wiener Sitzungsberichte. lvii. bd. 1868.]

THE length of the head was in the smaller specimens about one-fourth of their total length, but in the larger hardly one-fifth; it was at least as broad as high, or even broader; the mouth was terminal. Both jaws were armed, in the middle, with a single series (rarely several) of pointed teeth; the vomer and palate were paved with a series of larger, thicker, partly globular, partly obtusely-pointed, crushing teeth; a similar series of teeth was directly opposed to it below, probably placed on the hyoid bone; the palatine bones had also, apparently, a narrow longitudinal band of similar teeth. The upper part of the head was covered by thin plates radially furrowed. The eye, apparently small, was situated laterally, near the anterior end of the snout. The branchial fissure was covered by (probably two) conchiform opercular bones, one (by far the larger), the principal opercular bone, has its umbo directed upwards; the other and smaller one appears to have its umbo pointed downwards. The scapular arch was formed of a broad strong humerus, to which were attached the broad clavicular plates, uniting on the throat in such a manner as to form an angle with each other, as is the case in many *Siluridæ* and *Loricarinæ*. The branchial arches were broad, channel-shaped bones; the branchiostegous rays rather short and thin. The anterior part of the trunk was higher than the head, and the general outline reminded one, especially by the high and long peripherical (dorsal) fin, of the *Pleuronectidæ*. The dorsal fin, however, commenced beyond the middle of the total length, and extended backwards, lowering rapidly towards the tail point, immediately opposite the similarly constructed anal fin, near to which the rather small, few-rayed ventrals were affixed. The numerous slender articulated rays of the dorsal fin were supported by long, slender, hollow interspinous bones, reposing on similar spinous processes. The pectorals were attached behind the "shoulder-girdle," or scapular arch, about mid-way between the dorsal and ventral line, and were longer than broad, and many-rayed.

In the vertebral column the osseous centra were altogether wanting, and the notochord extended in a broad and rectilinear course to the very point of the tail; superior and inferior narrow arches were only partially developed, and the spinous processes were remarkably long and slender, as in *Cœlacanthi*, forming hollow tubes, as do also the numerous ribs.

The whole trunk was covered to the very edge of the fins by small and thin scales without enamel, mostly of a lengthened rhomboid shape, but varying considerably, being sometimes equally high as long,—sometimes, especially towards the dorsal and ventral profile, considerably longer than high, and losing the rhomboidal shape, and produced into a point. The greatest differences in size and shape are observed on the abdomen, behind the clavicular plates, where the crowded and delicate longitudinal striæ and furrows are replaced by ridges, radiating from an eccentric centre, calling to mind the covering of the thorax in many *Loricarinæ*. The lateral line runs parallel to the vertebral column, and has left behind the impression of the rather wide and long tubes, that may be seen towards the point of the tail.

The description is illustrated by four plates. On the affinities of this interesting fossil genus Prof. Kner gives no decided opinion; but the writer cannot refrain from asking, should this not be the *Cœlacanthus Münsteri* of Agassiz, of which a description was never published, but was stated by Prof. Huxley to be a peculiar extinct type allied to *Phaneropleuron?* In the second part of his paper (also with four plates) Prof. Kner dwells on the structure and characters of the *Acanthodes* of Lebach, adding to, and correcting in many important points, the contributions to our knowledge of this genus given by Troschel and Roemer. But as an abstract of this part of the Memoir cannot well be made, I shall refer palæichthyologists to the original paper itself, and only venture to insert here a sketch of a restored *Acanthodes*, based on the restoration of Roemer's and Kner's corrections, as a sort of graphic summary of our actual knowledge of the genus.



REVIEWS.

I.—Échinologie Helvétique. Description des Oursins Fossiles de la Suisse par E. Desor et P. de Loriol. Lv. I., II., III. Tabl. XII. Reinwald, Paris, and Kreidel Wiesbaden, 1868.

PALÆONTOLOGISTS have long been impressed with the importance of the study of the Echinodermata to the progress of Geology, for the marked differences between the forms of these fossils found in layers of different ages had long attracted the notice of observers. It is now upwards of forty years since Goldfuss gave, in the *Petrefacta Germaniæ*, admirable figures and good descriptions of the species found in Germany and in the adjoining lands, and the spirit his great work elicited was first manifested by the Swiss Naturalists, to whom we are indebted for the *Echinodermes Fossiles de la Suisse*, by Agassiz; the *Catalogue raisonnè des Echinides*, of Agassiz and Desor; the *Synopses des Echinides Fossiles*, of E. Desor; the *Synopsis des Echinodermes fossiles des Alpes Suisse*, of M. Ooster; and, lastly, the work now under consideration. Other countries, likewise, have contributed their Echinological fauna: thus the fossil *Echinides of France*, commenced by the late M. A. d'Orbigny, in the *Palèontologie Française*, have been ably continued by M. Cotteau; whilst the *British Echinodermata* are described in a series of monographs in the volumes of the Palæontographical Society, by Dr. Wright. Works which, taken together, form an important body of evidence on the history of the extinct species of one class of the Invertebrata. All these authors admit the great importance of the critical study of the test of the Echinoderm, which constitutes an internal portion of the body of the animal, participating in its life, intimately connected with the organs of digestion, respiration, and generation, as well as with vision and locomotion, and as a consequence having many of the distinctive characters of the organism indelibly impressed on different parts of the skeleton.

Each great epoch of the world's history has had its own special forms of this class. The Silurian, Devonian, and Carboniferous rocks are rich in wondrously beautiful forms of *Crinoideæ*. The Triassic, Jurassic, and Cretaceous formations are all characterised by numerous extinct generic types of *Echinidæ;* whilst the Tertiary stages possess groups of the same order that connect the Mesosoic fauna with existing species. The wonderful state of preservation in which many of these fossils are found, renders their study one of much interest, and the teaching derived therefrom, as regards the order of their history in time and space, is of the highest value, seeing that it is based on a very perfect knowledge of their organic characters. At a time when so much is said and written on the Darwinian hypothesis, we invite the special study of Echinoderms to the disciples of this school, as the delicate test of the Urchin has always appeared to us one of the hardest nuts the Darwinian has attempted to crack. In a well written preface, MM. Desor and De Loriol observe:—

"There is another point of view, which merits in the highest degree the attention of the palæontologist, because it presents quite a special interest in the group of animals which occupy us:—it is that of the part played by the Echinoderms in the history of the earth, and the verifying of the progress which they have made in the course of ages, and of the modifications which they have undergone from one age to another. In the Echinoderms, as in the Molluscs, the development of families is brought about in a very unequal manner; and if on one side we see the family of the *Cidaridæ*, continuing almost without variation, and remaining nearly stationary, from the Triassic to the present epoch, we find others, which have developed themselves gradually, enriched with new genera, modified more or less extensively, and often surprising us by the variety and abundance of the new forms which they present. It is important, however,—let us say it in passing,—never to forget, in this study of the evolution of types, that the consequences of an observed fact can be only relative, seeing the insufficiency of researches and the small extent of the field of observation. We can well say, for example, that until now, no genus of the family of the *Spatangidæ* has made its appearance before the Cretaceous epoch; but can we know if the attentive exploration of some Jurassic formations shall not at last reveal the existence of some precursor type? The frequency of similar discoveries ought to put the serious observer on his guard, and warn him that he ought always to be ready to modify his theories in proportion as the exact observation of some new fact comes to demonstrate to him that they were preconceived."

In the Livraisons before us the authors have described and figured the Jurassic *Cidaridæ*, embracing the genera *Cidaris*, *Rabdocidaris*, *Polycidaris*, and *Pseudocidaris*. The description of each species is clearly and accurately made, and their affinities and differences succinctly pointed out. The tables of synonyms, so important to a correct knowledge of fossil species, are compiled with great care and much discrimination.

The plates are good, but several of them have not been well printed, and are woolly and indistinct. The want of a clear definition in the details of fossil Echinidæ is a great defect in figures to which constant reference must be made, as standards of authority for the characters of forms that are often only found in a fragmentary state. Perhaps the future plates will be free from this defect, which is more the fault of the printer than the artist.

The work reflects very great credit on its authors, and we heartily wish it all the success its scientific merits so justly entitle it to.

T. W.

II.—SLATE AND SLATE QUARRIES, GEOLOGICALLY AND COMMERCIALLY CONSIDERED. By S. R. PATTISON, F.G.S. London, 1869.

SLATE is an article alike interesting to the geologist and economist, whether we regard with the one its mode of formation, or with the other the various uses to which it is applied. It is an essential adjunct to modern architecture; for although occasionally the red or glazed tile may be suitable for a certain style of building, the blue or green slate is certainly in the ascendant. From its lightness, imperviousness, and comparative durability, slate has to a great extent superseded the thatch, wood, and tiles; and even in the central counties of England, since the introduction of railways, it has largely replaced the more cumbrous Stonesfield and Collyweston flags, which, from their weight, required a stronger wood support. Slates, however, were used in the old fortresses of Wales, as well as in the castle of Angers, Brittany, built in the time of the Plantagenets, both near the centre of production.

The pamphlet before us is a reprint of a series of papers contributed by Mr. Pattison to the *Mining Journal* under the following heads: Composition and structure; Geology and Palæontology of the Slate rocks; Slate enterprise and trade, manufacture and sale; each of which is treated in a concise and readable manner, and contains a vast amount of interesting and practical information, which we are not aware has previously been condensed into so small a compass.

Slate consists principally of silica, alumina, and oxide of iron, with small quantities of other substances, as lime, magnesia, alkalies, etc., etc.; is about 2½ times heavier than water, and was originally a marine deposit of pure clay and sand derived from the decomposition of the older felspar-bearing rocks, but subsequently altered by mechanical movements and other agencies, so as to give rise to a slaty cleavage. The origin of this structure has long and frequently engaged the attention of geologists and physicists; but Mr. Pattison justly remarks that the Cambridge philosopher (Sedgwick) was the first to define and accurately describe the phenomena, so as to bring the facts into scientific order for practical use.

Cleavage must not be confounded with stratification, as was done by Saussure and the older observers; for although sometimes coinciding with it, the true lines of bedding may be frequently observed. Generally speaking, any slate quarry presents three different kinds of lines,—one set, usually vertical, termed joints; another parallel to each other or planes of bedding; and a third rarely coincident with either of the other two or the planes of cleavage. The mechanical theory, more or less modified, has been adopted by Sharpe, Tyndall, Ramsay, Sorby, and Poulett Scrope. The latter author attributes slaty cleavage to extreme pressure, occasioning internal movements and mutual friction in the particles of the solid mass, under which they became re-arranged so as to produce lamination; and Mr. Sorby observes that fine or imperfect cleavage depends on the original materials being fine or coarse.

Slate-bearing rocks in this country are confined to the Palæozoic series, and chiefly to the strata below the Coal-measures, although in the Alps slates are worked in the Lower Tertiaries.

Slaty cleavage is found in the Cambrian rocks, in the Lower Silurian, in which strata in Wales the proportion of cleaved rock to the general mass appears to attain its maximum; in the Upper Silurian, as at Llangollen; in the Devonian, as at Tintagel and Delabole; in the Lower Carboniferous, as in the south of Ireland, near Cornwall, around Dartmoor, and near Launceston. The so-called Stonesfield and Collyweston slates belong to the Oolitic rocks, and are only thin laminated calcareous flagstones, which split after exposure along the lines of original deposition. Cleavage, in Britain at least, is less and less displayed as we ascend in the Palæozoic rocks, and is of several epochs, for Prof. Ramsay has shewn that the strongest cleavage is found in the Cambrian, Lingula, and Tremadoc slates, before the deposition of the Upper Silurian, and then a second and more partial cleavage, well marked around Llangollen.

Mr. Pattison succinctly treats of the fossils of the slate rocks, showing that while the rocks themselves were originally sea-bottoms and beaches, formed under similar conditions to those at present, and from which area volcanic action was not absent,—these old seas contained a varied fauna, poor in the Cambrian, with its worm-burrows and doubtful zoophytes, but rich in the Lower and Upper Silurian strata, with their numerous invertebrata (Trilobites, Graptolites, Crinoids, Brachiopods), and the still higher Devonian, rich in corals, molluscs, and fishes.

The rough estimated value of English and Welsh slates is about £100,000 per annum, N. Wales yielding more than 350,000 tons annually, and giving employment to nearly 10,000 persons,—60,000 tons either as slabs or slates being sent to London alone.

Mr. Pattison's pamphlet may be fairly commended to the geological student and general reader. J. M.

III.—INDEX TO THE FOSSIL REMAINS OF AVES, ORNITHOSAURIA, AND REPTILIA FROM THE SECONDARY SYSTEM OF STRATA, ARRANGED IN THE WOODWARDIAN MUSEUM OF THE UNIVERSITY OF CAMBRIDGE. By HARRY GOVIER SEELEY, F.G.S. of St. John's College, Cambridge. With a Prefatory Notice by the Rev. ADAM SEDGWICK, LL.D., F.R.S., Woodwardian Professor and Senior Fellow of Trinity College. Deighton, Bell and Co., Cambridge. 1869.

THIS is the first of a series of guides for students, to assist them in making a profitable use of the extensive collections accumulated under the auspices of the venerable Professor of Geology. In the Prefatory Notice, the Professor commences by narrating how the Reptiles, Birds, and Pterodactyles came into the possession of the University, the number of which is estimated in the last report of the Museum Syndicate to be about 5150 specimens from the Secondary Rocks alone. Prof. Sedgwick warmly thanks those who have by their gifts enriched this department of the Museum. He also observes that those only can comprehend the great scientific labour bestowed upon the specimens by the author of the Catalogue, and the value of his conclusions, who have themselves previously studied the details of this difficult department of Palæontology.

The Index commences with a Table of the distribution of the animals in the Secondary strata, and the groups which they each contain. Then follows an approximate list of the species in the Museum, viz.:—Chalk, 8 species; Cambridge Greensand, 70 species; Gault, 2; Wealden, 12; Purbeck, 7; Potton Sands, 18; Portland, 1; Kimmeridge Clay, 10; Coral Rag, 3; Oxford Clay, 8; Lower Oolites, 4; Lias, 20. And of foreign reptiles, 15 species from the Trias, and 9 species from the Solenhofen slate.

A Table of the groups of the animals included in this Catalogue follows, arranged thus:—*Ornithosauria, Aves, Dinosauria, Dicynodontia, Ichthyosauria, Crocodilia, Plesiosauria, Chelonia, Lacertilia,* and *Ophidia.* The Secondary Strata of the South of England and those of the East of England are given in parallel columns. Mr. Seeley places the Hunstanton Red Rock a little above, and the Cambridge Greensand a little below, the Upper Greensand of the South of England. We now arrive at the detailed list of the specimens of Secondary Reptiles, &c., contained in the Cambridge Museum. The arrangement of the specimens is intended for educational purposes. The Osteological collection consists of bones, classified according to the part of the skeleton to which they belong, so that the student is able to trace the gradual variations of similar bones in different species. Each bone is numbered, so as to be easily replaced in its proper position in the case. We also observe that the peculiarities of many of the specimens are briefly and carefully noted. Thus, among the *Ichthyosauri*, we have, "Case 10, shelf b. No. 14. A small Atlas and Axis, very short from front to back, and at both ends heart-shaped, with the very long inferior sides convex." Again, among the Lias Reptiles, we find, "Case 87, shelf d. No. 2, 3. Cranial region of a large and undescribed *Teleosaur*, from the Lias of Whitby. It corresponds closely with the cerebral part of a *Plesiosaur* head. It has been sawn through to show the brain cavity, in which may be distinguished cerebral lobes, optic lobes, and cerebellum; also olfactory and optic nerves. It differs much from crocodiles, and makes some approach to serpents and turtles, and probably differs but little from the brain of a *Plesiosaur*. *Teleosaurs* make so many approximations to *Plesiosaurs*, as to show that they form a group of crocodiles of equal value with the crocodiles now living."

Some of the more remarkable animals recorded in this catalogue are the following:—Among the reptiles from the Purbeck strata we find four new species of *Pleurosternon*, and from the same strata a new species of a large Pterodactyle, *P. macrurus* (Seeley), represented by a fragment of the lower jaw, 12¼ inches long, and, where fractured behind, the rami measure 2¼ inches from side to side; and a caudal vertebra of the same species, 5 inches long. From the Kimmeridge Clay, we have a terrestrial reptile, *Gigantosaurus megalonyx*, indicated by a centrum of a cervical vertebra, 8½ inches wide and deep, and 4½ inches from back to front, and also by a caudal vertebra 6 inches long, 3¾ inches high, and 4 inches wide; and by two casts of a claw-phalange. The list of specimens from the Cambridge Coprolite bed occupies about half the book. The *Ornithosauria* are referred to a new genus, *Ornithocheirus*, and the twenty-four species are said to be chiefly founded on the characters of the upper jaw. The bones are briefly enumerated. There is a list of numerous fragments of *Aves*, referred to a new genus, *Enaliornis*. The *Dinosauria* are referred to the genus *Acanthopholis* (Huxley), besides which there are the remains of the remarkable animal, the *Macrurosaurus*, of which only caudal vertebra have yet been obtained. The *Ichthyosauria*, according to Mr. Seeley's views, afford evidence of the existence of at least four distinct species of *Ichthyosaurus*, besides *I. campylodon* (Carter). These new species have been founded on the characters of their humeri and femora. The *Crocodilia* are represented by *Crocodilus Cantabrigiensis* (Seeley). The *Plesiosauria* consist of twelve species of *Plesiosaurus*, of which seven species are new. Of one species of *Polyptychodon*, and three species of a new genus, *Stereosaurus*, in which "the limb bones develop neither heads nor trochanters" (p. 18). The *Chelonia* contain one species of *Emys*, one species of *Testudo*, one species of a new genus, *Trachydermochelys*, a new Emydian genus, which had an exterior pustulous ornamentation not unlike *Trionyx*, and was covered with scutes. The remaining sixteen species of *Chelonia* belong to a new genus, *Rhinochelys*, having for its type *Chelone pulchriceps* (Owen). It is Emydian in its affinities, and well characterised by having the nasal and pre-frontal bones distinct; by the posterior nares being formed by the maxillary and palatine bones, and divided by the whole length of the vomer, which extends on the palate between the palatine and premaxillary bones; and by the temporal region being covered by an arrangement of bones like that in *Chelone*. The total number of species of all these groups obtained from the Cambridge Greensand is seventy. In concluding this brief notice of Mr. Seeley's Index, we must express our satisfaction at the clear manner in which the descriptions of the bones are given, so that the student will find very little difficulty in making use of it, when he compares the specimens arranged in the Museum with any bones which he himself may chance to obtain. We hope that it may be soon followed by the illustrated descriptions of the new genera and species referred to in this work, until the appearance of which it would be premature to pronounce judgment on the many new forms here announced by the author, for the first time by name only.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. November 24th, 1869.—The following communications were read:— 1. "On the Dinosauria of the Trias, with observations on the Classification of the Dinosauria." By Prof. Huxley, LL.D., F.R.S., President.

The author commenced by referring to the bibliographical history of the Dinosauria, which were first recognized as a distinct group by Hermann von Meyer in 1830. He then indicated the general characters of the group, which he proposed to divide into three families, viz..—

I. The Megalosauridæ, with the genera *Teratosaurus*, *Palæosaurus*, *Megalosaurus*, *Poikilopleuron*, *Lælaps*, and probably *Euskelosaurus*;

II. The Scelidosauridæ, with the genera *Thecodontosaurus Hylæosaurus*, *Pholacanthus*, and *Acanthopholis*; and

III. The Iguanodontidæ, with the genera *Cetiosaurus*, *Iguanodon*, *Hypsilophodon*, *Hadrosaurus*, and probably *Stenopelys*.

Compsognathus was said to have many points of affinity with the Dinosauria, especially in the ornithic character of its hind limbs, but at the same time to differ from them in several important particulars. Hence the author proposed to regard *Compsognathus* as the representative of a group (*Compsognatha*) equivalent to the true Dinosauria, and forming, with them, an order to which he gave the name of Ornithoscelida.

The author then treated of the relations of the Ornithoscelida to other Reptiles. He indicated certain peculiarities in the structure of the vertebræ which serve to characterize four great groups of Reptiles, and showed that his Ornithoscelida belong to a group in which, as in existing Crocodiles, the thoracic vertebræ have distinct capitular and tubercular processes springing from the arch of the vertebra. This group was said to include also the Crocodilia, the Anomodontia, and the Pterosauria, to the second of which the author was inclined to approximate the Ornithoscelida. As a near ally of these reptiles, the author cited the Permian *Parasaurus*, the structure of which he discussed, and stated that it seemed to be a terrestrial reptile, leading back to some older and less specialized reptilian form.

With regard to the relation of the Ornithoscelida to birds, the author stated that he knew of no character by which the structure of birds as a class differs from that of reptiles which is not foreshadowed in the Ornithoscelida, and he briefly discussed the question of the relationship of Pterodactyles to birds. He did not consider that the majority of the Dinosauria stood so habitually upon their hind feet as to account for the resemblance of the hind limbs to those of birds, by simple similarity of function.

The author then proceeded to notice the Dinosauria of the Trias, commencing with an historical account of our knowledge of the occurrence of such reptilian forms in beds of that age. He identified the following Triassic reptilian forms as belonging to the Dinosauria; —*Teratosaurus*, *Platæosaurus*, and *Zanclodon* from the German Trias; *Thecodontosaurus* and *Palæosaurus* from the Bristol conglomerate (the second of these genera he restricted to *P. cylindrodon* of Riley and Stutchbury, their *P. platyodon* being referred to *Thecodontosaurus*); *Cladyodon* from Warwickshire; *Deuterosaurus* from the Ural; *Ankistrodon* from Central India; *Clepsysaurus* and *Bathygnathus* from North America; and probably the South African *Pristerosaurus*.

Discussion.—Sir Roderick Murchison, who had taken the chair, inquired as to the lowest formation in which the bird-like character of Dinosaurians was apparent, and was informed that it was to be recognized as low as the Trias, if not lower.

Mr. Seeley insisted on the necessity for defining the common plan both of the Reptilia and of the ordinal groups before they could be treated of in classification. He had come to somewhat different conclusions as to the grouping and classification of Saurians from those adopted by the President. This would be evident, in so far as concerned Pterodactyles, from a work on Ornithosauria which he had just completed, and which would be published in a few days.

Mr. Etheridge stated that the dolomitic conglomerate, in which the Thecodont remains occurred near Bristol, was distinctly at the base of the Keuper of the Bristol area, being beneath the sandstones and marls which underlie the Rhætic series. There were no Permian beds in the area. He regarded the conglomerates as probably equivalent to the Muschelkalk. It was only at one point near Clifton that the Thecodont remains had been found.

Prof. Huxley was pleased to find that there was such a diversity of opinion between Mr. Seeley and himself, as it was by discussion of opposite views that the truth was to be attained. He accepted Mr. Etheridge's statement as to the age of the Bristol beds.

2. "The Physical Geography of Western Europe during the Mesozoic and Cainozoic periods, elucidated by their Coral-faunas." By P. Martin Duncan, M.B. Lond., F.R.S., Secretary.

The author commenced with a notice of the typical species of the coral-fauna of the deep seas which bound continents remote from coral-reefs, and then made some remarks upon the littoral corals. The peculiarities of reef, lagoon, and shallow-water species were then explained, with the relations of the two faunas to one another. The author then referred to certain exceptional species, indicated the genera, the species of which constitute the existing reefs, and contributed to form those of the past, and noticed the representatives of some modern genera in old reefs. He pointed out that a correspondency of physical conditions during the deposition of certain strata was indicated by their containing analogous forms,—the presence of compound cœnenchymal species indicating neighbouring reefs, and their absence in places where simple or non-cœnenchymal Madreporaria are found being characteristic of deep-sea areas remote from the Coral seas. By applying the principles thus elaborated to the evidence as to the condition of the seas of the European area from the Triassic period to the present time, the author showed what must probably have been the physical condition of this part of the world at different periods.

DISCUSSION.—Prof. Alexander Agassiz accounted for the circumscribed area of many corals in the Atlantic, from the young of many coral species attaching themselves within a few hours of their becoming pelagic. He traced to the great equatorial current, which must have traversed the Isthmus of Panama and Sahara in a pre-cretaceous period, the distribution of certain forms, which the rising of the Isthmus of Panama eventually checked.. He thought that the limits of the depth at which true reef-building corals existed would be considerably extended in consequence of recent discoveries by means of dredging. He mentioned the formation of a reef at the present time off the coast of Florida, which threw light on the manner in which mudflats were formed and the sea eventually filled.

Mr. J. Gwyn Jeffreys objected to the term deep sea being applied to a depth of 10 fathoms only, when the tide in some places rose to that extent, and the laminarian zone extended to 15. He suggested 50 fathoms as a more appropriate measure. He remarked on the great vertical range of some simple species of corals, such as *Caryophyllia*, amounting to at least 150 fathoms from low-water mark. In deep-sea water it frequently was attached to various shells, such as *Ditrupa* and *Aporrhais*. The only other simple coral of our seas was never found at a depth of less than 75 fathoms. The compound corals occurred only at great depths.

Dr. Duncan drew a distinction between coral-reef areas and those in which different conditions prevailed. His argument had not so much been based on the depth of the sea as on the presence or otherwise of coral-reefs. The term deep sea had been given by Prof. Forbes to depths of 10 fathoms and upwards. For such depths as those explored at the present day no term short of "abyssal" was appropriate.

The President called the attention of the Fellows of the Society to a proposed memorial to the late Baron Alexander von Humboldt, and another to the late Prof. J. B. Jukes, in aid of which contributions were desired, and recommended these memorials to the favourable consideration of the Fellows.

II.—December 8th, 1869.—The following communications were read:—1. "Notes on the Brachiopoda hitherto obtained from the Pebble-bed at Budleigh Salterton, near Exmouth, in Devonshire." By Thomas Davidson, Esq., F.R.S., F.G.S., &c.

The author first described the general characters, and discussed the opinions that have been put forward as to the origin, of the pebbles forming this bed. Nearly 40 species of Brachiopoda have been obtained from them. The fossils contained in the pebbles have been regarded as of Lower Silurian age; the author considered the great majority of the Brachiopoda to be Devonian. The species identified with Silurian fossils are:—*Lingula Lesueuri* (Rouault), *L. Rouaulti* (Salter), and *L. Hawkei* (Rouault). The species regarded by the author as undoubtedly Devonian (*i. e.* either previously described from Devonian deposits or associated with such species in the same pebble) are twelve in number, namely:—*Spirifer Verneuilii* (Murch), *S. macroptera* (Goldf.), *Athyris Budleighensis* (sp. n.), *Atrypa* (*reticularis?*), *Rhynchonella inaurita* (Sandb.), *R. elliptica* (Schnurr), *R. Vicaryi* (sp. n.), and two undetermined species of *Rhynchonella*, *Streptorhynchus crenistria* (Phil.), *Productus Vicaryi* (Salt.), and an undetermined *Chonetes*. Eight species occurring in the same rock, three of which have been doubtfully identified, are considered by the author to be probably Devonian. The species supposed to be determined are:—*Orthis redux* (Barr.) and *O. Berthosi* (Rouault), Silurian; and *Spirifer octoplicatus* (Sow.), Devonian and Carboniferous, but possibly identical with the Silurian *S. elevatus* (Dalm.). The others are two new species of *Orthis*, and a new *Rhynchonella* (?), and an undetermined species of *Terebratula* (?) and *Strophomena* (?). Finally the author noticed fourteen species (all new, except *Orthis pulvinata*, Salt.) only known from these pebbles, but which were stated to possess a Devonian facies.

DISCUSSION.—Mr. Etheridge agreed with Mr. Davidson as to his determination of the species. He had, however, examined the extensive collection of Mr. Vicary, and, from their general *facies*, he was inclined to assign them to the Middle Devonian and Carboniferous beds. The attribution of the fossils to Upper Llandovery beds was founded on the presence of *Lingula crumena*; but he thought he could give some clue to the locality from which the pebbles had been derived. It had first, from the lithological character of the pebbles as well as from the fossils, been thought that they were of Lower Caradoc age. He himself assigned the position of the rocks from which the pebbles had been derived to the Hangman group of North Devon. At Anstey Cove Mr. Tawney had found a series of the same class of fossils in a matrix exactly like that of the pebbles. He had examined the spot, and there recognised an extension of the sandstones of North Devon (the Hangman Grits) on the South coast, and certainly, so far as lithological character is concerned, the rocks are the same as the pebbles. It did not, however, follow that the pebbles came from that particular district, but probably from the denudation of the large tract of country of Devonian age to the North. There are, however, Silurian species in the pebbles, and these he would refer to the denudation of rocks in an area mainly to the South of what is now the Devon coast. The fauna at Budleigh Salterton is essentially British and not French, though some few species are common to both areas. The bivalves, indeed, were hardly known in France. On the whole, he concluded that the fossils in the pebbles were Devonian, with a slight admixture of Silurian and probably Carboniferous forms, derived from rocks at no great distance from the spot where the pebbles are found.

Prof. Ramsay pointed out that in conglomerates it might be expected to find pebbles of rocks of various ages. He commented on the difficulty palæontologists seemed to labour under in determining a fossil if it came out of a pebble instead of from a rock, the position of which was definitely known. He adverted to the statement that the beds containing the pebbles had been deposited in the New Red Sandstone sea, whereas Mr. Godwin-Austen had regarded the New Red deposits as formed in large inland lakes; and the local character of the beds supported this latter view.

Mr. Prestwich was glad that some other source had been suggested for the quartzite pebbles. He had found somewhat similar quartzites between Lisieux and Cherbourg, in France.

The President observed that he would like to see the rise of a new race of palæontologists, relying simply on zoological characteristics, and not on geological position. A considerable reduction in the number of species would undoubtedly result.

Mr. Etheridge briefly replied.

2. "On the relation of the Boulder-clay without Chalk, of the North of England, to the Great Chalky Boulder-clay of the South." By Searles V. Wood, jun., Esq., F.G.S.

The author described the Yorkshire Glacial clays as of two kinds—the lower, containing chalk *débris*, and belonging to the uppermost member of the Glacial series in Eastern and East-central England; the upper containing chalk sparingly in its lower part, and gradually losing this upwards. On the coast the latter occurs only north of Flambro'. He stated that, Palæontologically, the lower and middle Glacial deposits closely agree with the Crag, and are quite distinct from the deposit at Bridlington, which he placed immediately above the "Great Chalky Clay."

The absence of chalk *débris* in the deposit north of Flambro' has been regarded as evidence of a drift from north to south; but the author stated that the purple clay without chalk extends over much of the north-eastern part of the Wolds, from the sea-level to an elevation of 450 feet, and that outlines of it occur at intervals along the Holderness coast-section as far as Dimlington, 42 miles south of the northern limit of the Wolds. In the direction of Flambro' and York the clay was said to be destitute of chalk, which would not be the case had the Wolds formed a sea-shore, causing a drift from the north to pass either to south-east or south-west.

The author described the characters of the Great Chalky Boulder-clay in the Eastern and Central counties of England, and maintained that the chalk found in it (equal, according to him, to a layer of at least 200 feet over the entire Wold) could only have been detached by the agency of moving ice, which he believed to have covered nearly the whole Wold for a long period.

The author stated that Boulders of Shap Fell granite are confined to the deposit of clay without chalk, and discussed the means by which they could have been distributed. He ascribed their dispersion to the agency of floating ice during an adequate submergence of the district. He supposed them to have passed from Shap Fell by what is now the pass of Stainmoor.

Thus he ascribed the formation of the "Great Chalky Clay" to the extrusion from the sea-foot of a great sheet of ice, of materials abraded by the latter, the land being depressed 600–700 feet below its present level; and that of the clay without chalk, and with Boulders of Shap Fell granite, to deposition during a period of much greater depression (about 1,500 feet), throughout which the sea bore much floating ice. He considered that the "Great Chalky Clay" indicated a long period, during which the land, with its enveloping ice, remained stationary, and that during this period, when intense cold prevailed, the Arctic fauna of Bridlington became established. He thought that the recommencement of subsidence was indicated by the reddish-brown or brownish-purple sediments of Holderness, in which some chalk occurs. He then indicated the species of Mollusca which have occurred in the purple clay without chalk about Scarbro' and Whitby, all of which were said to belong to existing forms, and thus to be in accordance with the date assigned by him to that deposit. The Molluscan fauna of Moel Tryfaen was referred to by the author, who stated that he regarded it as belonging to the period of emergence from the deepest depression during which the clay without chalk was assumed to have been deposited, *i. e.*, to the earliest part of the Post-glacial period, to which the stratified drifts of Scotland are referred by Mr. A. Geikie.

Discussion.—Mr. Gwyn Jeffreys had found the shells of Kelsea and elsewhere in Yorkshire to be mainly Arctic, and Mr. Prestwich, in his paper on the Boulder-clay near Hull, had first pointed out their glacial character. In the late dredgings in H.M.S. 'Porcupine,' several of the species before known as fossil at Bridlington, but not as existing in the British seas, had been discovered. In fact he believed that the Bridlington species, with but few exceptions, had now been found in the British seas. Similar species had also been found in the Boulder-clay in Scotland.

Prof. Ramsay was pleased to find the author's views so closely correspond with his own, published some years ago, as to the glacial phenomena of North Wales, though based on another part of the country. He thought that shells might be found by careful search in the low-lying Boulder-clay in other places than those enumerated, as they had been discovered in the western part of England.

Mr. Prestwich, though inclined to accept the divisions of the Boulder-clay in Yorkshire, as suggested by the author, was not so clear as to his divisions in the south. He thought the presence of chalk in the clay might be traced to the contiguity of the outcrop of the chalk stratum. The shells being to a very great extent recent, the grouping might be due to accidental or local circumstances. The Chillesford clays, in his opinion, mark the commencement of the great glacial period.

Mr. Etheridge suggested that *Nucula Cobboldiæ*, *Cardita senilis*, and some other shells not found in the British seas, proved the arctic character of the Bridlington fauna.

Sir Charles Lyell remarked that if the fauna of the Lower and Middle Glacial really corresponded so closely with that of the Crag, it afforded a strong argument against their being of the same age as the Bridlington beds. Perhaps, eventually, some palæontological connexion might be traced throughout the series, and a chronological scale established.

The President suggested a difficulty in the marine transport of ice from Shap Fell to Bridlington, not only from the wind blowing rarely in the necessary direction, but from the current caused by the great submerged ridge also tending to carry any bergs in another direction. He thought the transport by sheet ice more probable.

The Rev. J. L. Rome had traced the Shap granites over the valley of the Eden, across Stainmoor to the Yorkshire side. There might have been difficulties in their transport, but there they are. Though they were found in Teesdale, yet the intervening ridge of Millstone-grit, 2000 feet, had prevented them finding their way into Swale Dale.

Mr. Searles V. Wood, jun., stated that he had relied on Mr. Gwyn Jeffreys' work for his classification of the shells as being Arctic or otherwise. He regarded the succession of the various members of the Glacial series of the Eastern side of England as well founded, and borne out also by the molluscan remains. He utterly repudiated the notion that the Chillesford, Bridlington, and Kelsea Hill beds were on the same horizon. He believed nearly the whole of the Scotch beds to be newer than those of the Middle and Lower Glacial. He quoted Prof. Phillips as suggesting a change in the relative elevations around Shap Fell since the dispersion of the boulders, and offered as his own explanation of the hypothesis that the passes by which the boulders travelled were those which, though at the higher levels, were the soonest freed from ice. He thought that the direction of the current was influenced by other causes than the general trend of the rocky dividing ridge.

EDINBURGH GEOLOGICAL SOCIETY.—ANNIVERSARY ADDRESS BY THE PRESIDENT, ARCHIBALD GEIKIE, F.R.S.—At the Thirty-sixth Anniversary Meeting of the Society, the President, Mr. Geikie, delivered the opening address. After congratulating the Society on its recent progress, he passed on to notice three special branches of inquiry, wherein much useful work remained to be accomplished. The first of these related to the study of organic remains, which, in the opinion of the speaker, was too much dissociated from that of the strata in which they are preserved. He thought that the palæontology of each geological formation should be, as far as possible, the natural history of a certain period of the past life of the globe. We should try to discover from the fossil remains more of the general character of the contemporaneous fauna and flora; the nature of the sea-bottom or land-surface on which they flourished; their various modes of growth; their distribution in space as well as in time; the light which they cast upon changes in the inorganic world, and the influence of these changes upon them; the causes of their decay as individuals and as species, and the circumstances under which they had been finally entombed. Mr. Geikie illustrated this subject from the rocks of the central valley of Scotland. He then passed on to the second topic, which related to the mineral structure of rocks, or petrography. That branch of the science had fallen into strange neglect in this country. After indicating what had been done, and what was now doing in Germany, in that department, he pointed out the special way in which it lay open to observers in Scotland, and pressed upon the Society the desirability of cultivating it. The third branch of his address bore on the balance of the various forces which have been instrumental in modifying the surface of the earth. Observers in Britain, he said, enjoyed special advantages when they set themselves to investigate this question. The completeness of their geological series, the diversities of configuration in their country, the extent of their coast line, the multiplicity and variety of their brooks and rivers, all conspired to aid them. On the other hand, they were apt, from this very completeness of their opportunities, to take a local and limited view of the phenomena. This, he thought, had really happened in the case of their estimate of the potency of the sea as a geological agent. Their position as islanders had led them to take an exaggerated view of the results attributable to the waves in the general economy of nature, and to undervalue the power of rains, springs, frosts, and rivers, which in this country do not produce the changes which they effect elsewhere. He pointed out how vast was the extent of coast-line where the sea did not reach the solid framework of the land, but was barred back by long lines of alluvial deposit—the waste of the land brought down by the streams. The sea in these instances, although perpetually wasting the sandbars, did not perceptibly encroach on the land, for the bars were constantly being renewed from behind. The land, though not diminishing in breadth, was inch by inch sinking in height, the power of the sea being no more than equal to sweeping away the detritus brought down to the coast by the drainage from the interior. Although seemingly paradoxical, he yet believed that, in the general balance of forces, the influence of the ocean is more conservative than destructive, there being a greater area of rock under the sea, and preserved there from that universal corrosion and removal which befalls every part of the earth's crust that rises above the waves. The concluding portion of the address was as follows :—

Science and Religion.—In conclusion, there is still a subject upon which I feel impelled, though not without reluctance, to allude on this occasion. I mean the relation at present subsisting between science, especially our branch of science, and religion. It is a difficult and delicate topic, which it seems hardly possible for any one to handle without the certainty of being either misunderstood or misrepresented. Let me state at the outset that I have no controversial aim. I do not wish to enter into any argument, but rather to define what it seems to me is the position to be taken and maintained by such a society as ours. It is sadly unfortunate that so sharp a line of demarcation should have been drawn between religion on the one hand and science on the other. This seems to me, indeed, to be only another illustration of that exclusiveness which has marked the history of religious belief. Religion has been separated from the other concerns of man, as if it were a work to be considered and pursued apart, instead of being the life and essence of all human duties. Science, which ought to be, and is, of one flesh with religion, has suffered in the universal divorce,—nay, is even regarded as in many respects either actively or passively antagonistic to religion. Men devoted to the cultivation of science necessarily share in the disfavour which attaches to the subjects they study. We cannot conceal from ourselves that the students of our own branch of science, in particular, are regarded with suspicion by a considerable section of their fellow-countrymen. They are by some supposed to have interests directly at variance with those of religion, or at least with those of that portion of the community which delights to call itself "the religious world." They seem to be looked upon as in some way banded together for the subversion of all religious belief, and for the introduction of rationalism, infidelity, and atheism. I will not say that such charges have never any shadow of foundation. It is only too true that now and then a man steps out of the ranks of science, and so goes out of his way, to make an unprovoked and needless attack upon beliefs that are consecrated with all that is pure and holy in the hearts of his friends and countrymen—an attack which, if it does no harm to these beliefs, can hardly be considered as doing any good to science. But it would be as unfair to judge of the temper and aims of scientific men in general from such displays, as it would be to estimate the tone of thought in the Church from the occasional eccentricities of a rabid ecclesiastic. Nevertheless, we know that the distrust of science and scientific men is widespread. No feeling of this kind can exist and continue without doing injury, both to those who entertain it and those against whom it is entertained. It should be our aim to do all we honestly and honourably can to allay the distrust, knowing that while we cannot but be the better for the sympathy and encouragement of our fellow-men, they in turn must needs derive many advantages from the onward march of science. They and we have no interests apart: we are all one in our desires for the welfare and advancement of our common humanity. Let us therefore avoid all needless provocation of controversy. I fear that, in Scotland, profitable controversy is in the mean time impossible. So much of the *odium theologicum* is at once imported into the discussion, that all impartial consideration of the subject is nearly hopeless. Let us be on our guard also against an arrogant or contemptuous tone towards our assailants. A man of science may be, in his own way, as intolerant as the opponents whose narrow-mindedness he ridicules. It is indeed difficult at times to restrain the natural indignation which arises when we see the flippant criticism of men who ostentatiously proclaim their ignorance of what they criticise, or when we hear the public warned against science and scientific men as dangerous and subversive of religion. And though we may feel called upon now and then to speak out in protest, yet if our cause be as true and noble as we believe it to be, such opposition can deal it no permanent injury. Strong in this assurance, we may well refrain from seeking often to vindicate it. Thus shall we best conserve the modesty and dignity of true science. The slow growth of truth is like the protracted rise of a great cathedral—its very tardiness is evidence and guarantee of strength and durability. But while I recommend the quiet following out of our own special work, let no one suppose that I would for one moment counsel anything that bore even the remotest aspect of pusillanimity. To conceal anything we know or believe, from fear of the consequences to ourselves of its being divulged, could not but lower us in the estimation of the outer world, and, what is worse, it would lower us in our own. Nor could we hope to retain our self-respect if, when occasion called, we shrank from defending opinions which in our own inner soul we believed to be true. Yet it is surely unnecessary, in the spirit of knight-errantry, to ride about the world charging whatever we may think to be prejudice or error, but which really does not oppose our progress. Let us rather be content to labour and to wait. Time, that great winnower, will sift the true from the false: what of error may be in our work will deservedly perish; what of truth it may contain will assuredly live. In reflecting upon this question of the relations between science and religion, and especially upon the opposition which science encounters from many thoroughly honest and estimable men, I am profoundly impressed by the significance of the evidence of continual change in the past history of the universe. The book of nature, like the prophet's scroll, is written within and without; and over all that vast palimpsest, the dominant idea, expressed in thousands of varied and ever-varying forms, is the idea of continual progression. As far back in time, and as far away in space, as our powers of observation can lead us, we find evidence of this onward march of creation. It is stamped on every lineament of the globe upon which we dwell; there is not a mountain or valley, not a river-bed or seashore, that is not eloquent of change. And when we come to decipher the records of our planet's history, enfolded within its rocky crust, we find that what is true of mere dead matter is yet more marvellously true of organised existence. Down in the rocks beneath us lie the cemeteries of unimagined ages, piled one over another, each with the buried relics of long extinct tribes of plants and animals. From these we can in large measure follow the history of life upon the globe. We learn that there has been a slow upward advance from the lowliest types of organisation through the whole range of the animal and vegetable kingdoms to the complex forms of the present time. We may frame what theory we please to explain the method of their progress. We may suppose it to have been brought about by a continued succession of special creations of new species and genera, or by a gradual development of more advanced forms out of those which had preceded them. Still the great fact of a mighty progress of life remains, and it is this fact which seems to me so full of significance in its human relations. If we turn to the history of man himself, the proofs of advancement crowd upon us on every side. Beneath our feet, buried under gravel and soil, lie the rude canoes, stone hatchets, and flint arrow-heads of our savage forefathers. Above ground are the towns and cities, the telegraphs and railways, the religion and literature, the sciences and arts of the nineteenth century. Among the many contrasts with which nature abounds there is surely none more wonderful than this. Man, therefore, is no exception to the universal law of progress. Nay, that law finds in his history one of its most signal illustrations. His career has had its vicissitudes, and will no doubt have them again; but it has nevertheless been an upward one, and such we cannot but believe it will continue to be. Now, in this onward progression there is no part of man's nature left unaffected—none of his powers have been dormant. Physically, mentally, morally, we are far in advance of our wild ancestors. Nor are there any symptoms that our development is complete. And if this progress is to continue, as we believe it will do, can we suppose that any one of our faculties will remain at its old level, or show no token of further development! Least of all can we imagine that this inactivity, or arrested growth, will befal the highest powers of our being. No. Our religious nature must share in the universal progress. It is impossible that the creed of one age can satisfy the wants of all succeeding ages. As well might we seek to replace the rifle bullet by the flint arrow-head, or to return to the ancient quadrireme instead of the modern monitor. Those who would seek thus to fetter human thought are struggling against the whole analogy of nature. The grand essential truths will remain ever with us, but the outer crust of prejudice or misconception in which they may be more or less encased must piecemeal fall away. It is against this outer incrustation, and not against the eternal truths which lie within, that science offers any antagonism. So far, therefore, from feeling disquiet, we ought to rejoice at every fresh discovery which, by breaking down prejudice, superstition, and error, tends to enlarge the boundaries of our knowledge. Such discoveries show that we share in the universal progression; they furnish the happiest augury for the future of our race. Between true religion and true science I believe that there never has been and never can be any real discordance.

It is imperfect knowledge on one subject, or on both, which leads to antagonism, and to all those unhappy bickerings which are so much to be deplored. As Helmholz well said at the late scientific meeting in Innsprück:—"Full knowledge of the truth always brings with it the cure for the damage which imperfect knowledge may occasion." Firmly convinced of this truth, let us continue our work with the most perfect freedom and fearlessness, yet with modesty and in the spirit of love, guided by a clear-sighted faith in

"One God, one law, one element,
And one far-off divine event
To which the whole creation moves."

CORRESPONDENCE.

NOTES ON CONTINENTAL GEOLOGY.

SIR,—I am requested by M. Hebért to inform your readers that he has just returned from a long journey, which he had undertaken to study again the Upper Chalk in the North and the *Titonique* in the Alps. At Innsprück he met Prof. Zittel, a gentleman advantageously known on account of his excellent work on the Cephalopoda of Stramberg, and who now declares himself inclined to locate the *Limestone of Stramberg* in the Neocomien, so that his own views were apparently gaining fresh ground.

M. Hebért desires likewise to make two rectifications of his tables of classification of the Cretaceous system inserted at p. 200 of last year's volume of the GEOLOGICAL MAGAZINE; namely, that, on account of the recent studies he has made in Sweden and Denmark, it would appear that he has placed the *Limestone of Saltholm* a little too low down in the series. Formerly it had been considered more ancient than the Chalk of Meudon and Norwich, and in Angelin's Geological Map of Scania it is placed under the Chalk of *Tullstrop*, which last is equivalent to the Chalk of Meudon and Norwich with *Belemnitella mucronata*.

In M. Hebért's table above quoted, and from observations made by him in 1865, the limestone of Saltholm is placed above the Chalk of Meudon, and he had assimilated it as to age with the Chalk of Ignaberga, as well as to the gray beds of Ciply. Prof. Johnstrup,[1] of Copenhagen, and Dr. Lundgren, of Lund, have ascertained that at Limhamn in Scania some beds of this limestone of Saltholm repose on the Chalk of Taxö (Faxoe), that he has verified this fact during his recent journey, but that at the same time, as will be hereafter explained in greater detail, he believes he has made out that in other localities some layers of this same limestone occur under the Chalk of Faxoe. He has therefore been led to consider the limestone of Saltholm as a simple *facies* of the Chalk of Faxoe as well as the *Limsteen*, and that the three deposits will require to be placed together in the same series with the Chalk of Maestricht.

M. Hebért desires it also to be understood that the words "wanting," "wanting," in his division of the Gault refer solely to the columns in his table which are devoted to Touraine and Maine and Aquitaine, and not to Southern France and Switzerland, where the Gault division is largely represented.

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[1] ? Steenstrup.

M. Lory begs me likewise to state that in his tabular view (p. 252 of last year's Vol. of the GEOLOGICAL MAGAZINE), a simple line without connecting braces should divide the two columns respectively devoted to the Jura, and to Grenoble; that he does not believe the yellow Limestone of Neuchatel to be the equivalent of the limestone with *Chama ammonia*, but rather considers it more closely connected to the etage which underlies it. That in the 2nd column the words "corresponding to a complete change of fauna" refer exclusively to the word "break," and not as the brace would seem to imply to a series of beds in the opposite column, and which are the equivalents of the Kimmeridge clay.

I avail myself of this opportunity to mention that, as so many of my geological friends have expressed a desire that I should endeavour to complete my large work on British fossil Brachiopoda during the present winter, I am unavoidably compelled to postpone the publication of the continuation of my "Notes on Continental Geology" until the labours connected with the work above named will have been completed. THOS. DAVIDSON.

22, PARK CRESCENT, BRIGHTON.

MR. DE RANCE & THE REV. T. G. BONNEY ON SURFACE-GEOLOGY AND LYTHODOMOUS PERFORATIONS.

SIR,—I regret that Mr. De Rance's able article on the Surface-geology of the Lake Districts, in which he repeatedly refers to an article by me in your number for July, 1865, was written before the publication of my work on the *Scenery of England and Wales* (reviewed in your number for October last), in various parts of which the Denudation of the Lake District is fully considered. In reply to several of Mr. De Rance's observations, I would remark—(1) that I don't regard the probable absence of erratic blocks on the Pennine Hills at a greater height than 1800 feet above the sea as a presumption that the Lake District was not submerged to a greater depth than that implied by these erratics, because at a greater depth the extent of coast-ice, or floating glacier-ice, capable of transporting blocks, must have been much reduced, owing to the decreased area of land above water, and likewise perhaps owing to an amelioration of climate, to say nothing of possible changes in the direction of currents. If I mistake not, erratics transported from short distances have been found in the Lake District which must have been floated over ridges rising to a greater height than 1800 feet above the present sea-level.

(2) Deflected or branching sea-currents, assisted by waves, may have acted very powerfully on the western side of Thirlmere Valley at the time when it was a strait; and supposing the eastern side of Helvellyn to have been once a longitudinally-strait slope, consisting of rocks varying in structure and hardness, the sea undoubtedly would have broken up this slope into coves and capes. Were the sea now to attack the eastern side of Helvellyn, it would probably destroy the edges, and fill up the cwms, because the sea generally

impresses a *new* configuration on a land-surface.[1] This remark applies to sea-coast action, but I think it probable that Red Tarn Cwm was mainly excavated by currents.

(3) In Red Tarn Cwm, and other cwms of the Lake-district, frost and rain are breaking down their sides and raising the level of their bottoms—in other words, these agents are doing the very opposite of making a cwm. They are acting precisely the same as they would on a hill-side quarry, and springs present precisely the same relation to cwms as they do to quarries,[2]—in other words, springs have been developed by, but have not been the cause of these excavations.

(4) Cwms, passes (the latter frequently indicating a greater amount of excavation at their summit-levels than towards each end), and valley-expansions, form the most striking features of the scenery of the Lake District, and I believe none of them can be explained by the action of rain and fresh-water streams. The latter, however, have excavated numerous V-shaped gulleys on the sides, or at the bottoms, of the larger valleys.

(5) Most of the lakes in Cumberland and Westmoreland with which I am acquainted, especially those fed by small streams, show few or no indications of sediment being transported from one end to the other. The bottoms and sides of many lakes, excepting at their upper ends, consist almost entirely of bare stones or rock.

Lithodomous Perforations.—From the Rev. T. G. Bonney's descriptions, I do not think he was fortunate in meeting with very perfect specimens of lithodomous perforations in the Llandudno Peninsula. Near the summit of the Great Orme's Head, I found groups of them in a heap of newly disinterred stones, many of them more than three inches in length, and very smooth and regular. In Hill Head Valley, about three miles S.E. of Buxton, and between 1300 and 1400 feet above the sea (as noticed in my paper in the Quart. Journ. Geol. Soc. for last August), I met with hundreds of perforations about seven-eighths of an inch in diameter, and frequently 3½ inches in length. The distinction between them and structural, or weather-worn holes in rocks, was very strongly marked. *No land-shells were to be met with in any of them,* so far as I can recollect.[3] The Rev. T. G. Bonney has corroborated my assertion in the Q. J. G. S., that most of the lithodomous perforations occur in positions protected from the action of rain.

D. MACKINTOSH.

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[1] On coasts now existing, the sea makes a headland, and in time breaks it up.

[2] Or to marl-pits on the sides of drift-knolls.

[3] Mr. Cameron, of the Geological Survey, Ulverstone, has in his possession a disused limestone gate-post I found on a roadside near Birkrigg Moor. On one part of it there is a group of deep holes more regularly ground out than a hole made by an iron jumper on the same slab of rock. From one of these holes Mr. Cameron extracted *seventeen* land-shells! Did each of the snails take a turn at boring, while the others rested from their labours? or did one snail bore the hole, and then extend to a number of brother snails the benefit of a sheltered habitation? The late Dr. S. P. Woodward decided against the snail-theory of M. Bouchard-Chantereaux, and Miss Hodgson, now revived by the Rev. T. G. Bonney. (See Editorial Note to my article on *Pholas*-borings, GEOL. MAG., Vol. IV., July, 1867.)

We would refer our readers to Mr. Rofe's article in the present Number, p. 4.—EDIT.

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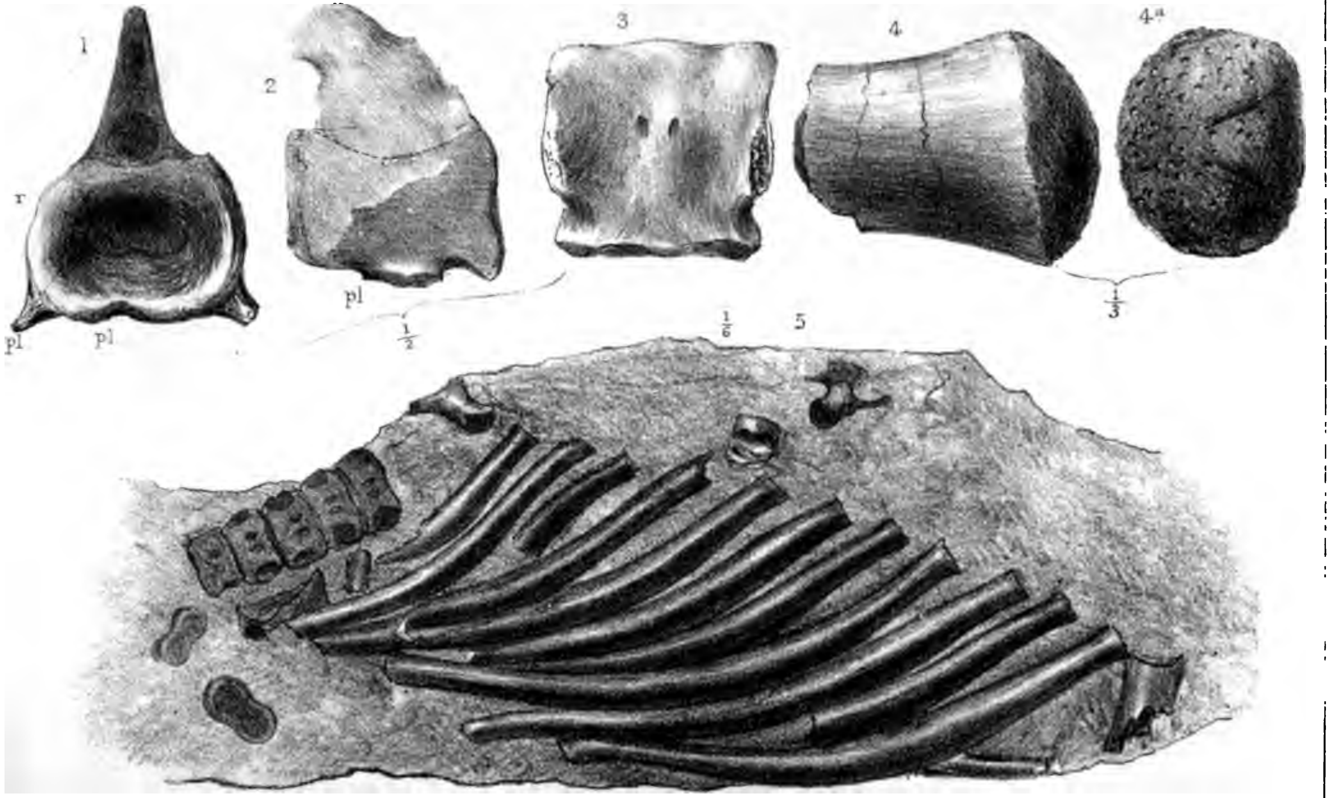

F. Fielding, lith.

W. West imp.

THE

GEOLOGICAL MAGAZINE.

No. LXVIII.—FEBRUARY, 1870.

ORIGINAL ARTICLES.

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I.—Notice of some Saurian Fossils discovered by J. H. Hood, Esq., at Waipara, Middle Island, New Zealand.

By Prof. Owen, F.R.S., F.G.S., &c.

PLATE III.

IN the year 1861 I communicated to the Geological Section of the British Association, which that year met at Manchester, a description of certain fossils discovered by J. H. Cockburn Hood, Esq., in the Canterbury Settlement of the Middle Island of New Zealand; which fossils, kindly submitted to me for description by that gentleman, were afterwards presented by him to the British Museum.

These fossils, having characters most nearly resembling those of Sauropterygian Reptiles, were referred to a species named, provisionally, *Plesiosaurus Australis*.

On Mr. Hood's return to New Zealand, in 1869, he resumed his researches for evidences of Mezozoic deposits in the Middle Island ;[1] and I received from him, in August, 1869, the following notice of his success :—

"Christchurch, Canterbury, New Zealand, May 15th, 1869.

"My Dear Professor Owen,—I have already written to you this month, telling you that I had spent another week in the exploration of the ravines at the 'Waipara,' and have been very successful in obtaining fine specimens of the remains of Reptilians of at least three species. The head I mentioned having obtained seems to be that of a creature resembling *Teleosaurus*: perhaps the portion of the femur, found near, may have belonged to the same; if so, he must have carried himself well off the ground when crawling along the old river banks (?), or by the shores of the gulf of the old Southern Continent (?).

"Since discovering these remains, in another ravine, some six miles distant, my friend Mr. Innes and I found other very interesting fossil bones—a portion of backbone (12 vertebræ), concave on both sides, coracoid and other bones, of a very large lizard fish (*Plesiosaurus*, perhaps?); the vertebræ are rather more hollowed on the anterior than the posterior side; also tail-vertebræ, humerus, &c., I think of an *Ichthyosaurus*.

"My geology of the district is not very easy to map out, and, without further research, somewhat puzzling. As I told you, it is no easy matter exploring it, the deep impassable ravines making it, in places, almost inaccessible. I am writing in an uncomfortable Colonial steamer, rolling most horridly, but must try and give a rough sketch, for your information. In the clay-beds in which the boulders are imbedded I have found no fossils, except those surrounded by crystalline concretions. If it were certain that the beds are marine, it might be that the fossils were washed out of the cliffs of an older rock into the Eocene sea; but, as it is, I see no reason for calling them Tertiary.

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[1] In the North Island the regular and highly-inclined beds of marl on the South Head of Waikato and western shore of Kawhia Harbour have been referred by Hochstetter to the "Secondary period," on the ground of his discovery therein of Ammonites of the family *Canaliculati* and *Belemnites*. I believe the Reptilian remains about to be described afford as sure ground for a like reference of their matrix.

"SKETCH.—No. I. shows the deep gorge of a tributary of the Waipara river, cut up by floods in the most fantastic and strange manner; the precipitous cliffs, in places only 30 ft. or so apart, are many hundreds of feet in height; so that the great concretionary boulders stand out in relief against the sky.

"No. II. is the deep ravine in the Limestone plateau, with large caves and a natural bridge; the Limestone here passes into Chalk, and is full of a peculiar cup-shaped Coral, Bryozoon (?) and Echini. Cetacean remains are plentiful.

"No. III. Waipara river-gorge, surrounding the plateau called 'Raui paddock,' formed by great subsidence and denudation of Red Crag. This plateau is about 8½ miles long and 3 miles wide.

"I am afraid that my wretched writing material and worse drawing will not make this hasty attempt to show the peculiar conformation of the place very intelligible; but it may serve to give an idea, meantime, until I have the pleasure of seeing you, or can send something better, if I do not go on to England.

"I think that the conclusion you will come to is that these beds are the equivalents of the Wealden. I am very sorry that I had not another week to spend there, to have enabled me to examine the clay-beds more thoroughly, and underlying sand-*rock*, not sand-*stone*. I am sure, however, that their being Miocene or Newer Tertiary strata is incorrect. "Yours very sincerely,

(Signed) "J. H. COCKBURN HOOD."

"P.S.—There are undoubted Triassic beds in the adjoining province of Nelson.

"The boxes have gone in the 'Matoaka' to London."

I soon after received the following:—

"Christchurch Club, Canterbury, New Zealand, May 18th, 1869.

"MY DEAR PROFESSOR OWEN,—I wrote to you by last mail, and send this to let you know what I have sent home by the 'Matoaka,' in case it reaches England before I do myself. The numbers I give to distinguish the fossils found in each Boulder, some being 10 miles apart. "I am, yours sincerely,

(Signed) "J. H. COCKBURN HOOD."

LIST OF FOSSILS AS FOUND IN THE DIFFERENT BOULDERS.

No. 1. Portions of head, upper and lower jaws.

No. 1*. Point of *ditto*, of a large Crocodilian (*Teleosaurus ?*).

No. 2. Caudal vertebræ, *Plesiosaurian*; the two last broken.

No. 3. Lower part of femur (of a land-Saurian); with this were vertebræ and ribs; 6 and 8, very cylindrical; second rib 15 inches long; one was 18 inches.

No. 4. Ribs, etc., etc.

No. 5. Vertebræ and humerus (*Ichthyosaurus ?*).

No. 6. Large, ditto.

No. 7. T-shaped bone of sternum.

No. 8. Vertebræ, fresh teeth, *Ostrea*, etc.; shells frem coal-seam underlying Saurian (boulder)-bearing deposit.

No. 9. Vertebræ, convex on anterior, concave on posterior, side (from boulder, apparently from coal bed).

No. 10. Clavicle (found alone).

No. 11. Ulna (found alone).

No. 12. Coracoid bone (found alone).

No. 13. Paddle 1 (alone).

No. 15. Part of backbone (12 large vertebræ); bones of sternum, pelvis, etc., etc., apparently allied to *Teleosaurus*.

No. 16. Cetacean, from overlying Tertiary.

No. 17. Fucoids, etc., etc., from bone-bearing boulders.

No. 18. Sulphureous clay, shells, etc, from boulder-bearing strata.

Mr. Hood returned in safety to England about two months after my reception of his last letter. He informed me that a vessel which left Christchurch, with a quantity of the *Phormium tenax* on board, had perished through spontaneous combustion of the cargo, and that the crew had been picked up after much suffering in the boats. The "Matoaka" had left with a similar lading, before tidings of the catastrophe had reached Christchurch, and as nothing has been heard of that vessel, now some months overdue, it is feared that she has also perished.

Some fossils from the locality at Waipara, explored by Mr. Hood, and from another locality, of the Nelson Province, have fortunately been preserved in the Colonial Museum at Wellington, New Zealand; and I have been favoured by receiving from Dr. Hector, F.R.S., the experienced Government Geologist of that Province, outline drawings of some of these fossils, of the natural size. From these drawings I have selected subjects which most unequivocally represent a species of Sauropterygian Reptile. They are represented, reduced, in Plate III.

Figs. 1–3 are of a cervical vertebra. It is broad and flat on the under surface of the centrum; the sides, also, of which, between the terminal articular surface, are more flattened than usual, and converge toward the neural surface, giving somewhat of a triangular figure to the vertical transverse section of that part. The pleurapophyses (*pl.*) come off from the lower part of the sides, and are confluent therewith, like transverse processes. The characteristic pair of venous foramina open upon the middle of the under surface, fig. 3. This vertebra most resembles one from the bone-bed of Aust-Cliff, near Bristol, described in my "Report on British Fossil Reptiles," 1839, p. 78. and referred, with a note of interrogation, to the *Plesiosaurus trigonus* of Cuvier. The articular surface of the centrum, fig. 1, is moderately concave, with a transversely oblong depression in the centre, and the margin rounded off. The neural arch is anchylosed to the centrum. The neural canal, fig. 1, is contracted, as usual, in cold-blooded air-breathers, and shows the ordinary proportion of that in *Plesiosaurus*. The pleurapophyses (*pl.*) are short and thick; the fore and aft diameter of their base equals two-fifths of that of the entire centrum: they are somewhat inclined downward. A distance of twice their vertical basal diameter intervenes between them and the anchylosed base of the neurapophysis, (*n*) figs. 1, 2.

This vertebra gives the following dimensions:—

	In.	Lines.
Length of centrum	2	1
Breadth of articular end of ditto	2	2
Height of do. do., at the middle	1	7

The New Zealand specimen shows an exceptional form among the extensive series of modified plesiosaurian cervical vertebræ already defined or recognized. Moreover, it is that form which, hitherto, from British deposits, has not been met with associated with other parts of the frame, yielding the characters of proportionate length of neck; proportion of head to body; shape and number of teeth; form, structure, and proportions of limb-skeletons, either in relation to the trunk, or in that of the pectoral pair to the pelvic pair. In short, materials have been wanting for assurance that the degree of modification of the cervical vertebra, represented in Pl. III., may not have been associated with so much modification of the rest of the skeleton as to warrant a generic section of *Sauropterygia*, or a subgeneric one in the Plesiosaurian family. I leave, however, to him, who may have the good fortune to receive the requisite evidence, the privilege of propounding the generic term.

Meanwhile, one has the satisfaction of seeing this type of Sauropterygian cervical vertebra, which appears, with us, to be geologically related to a Triassic deposit, repeated in fragments or boulders of a broken-up part of, what the present evidence suffices to convince me has been, an old Mesozoic shore or sea-bed in New Zealand.

In Fig. 5 of Plate III. is given a reduced copy of a sketch of part of the skeleton of a Plesiosauroid, in which twelve ribs of the left side succeed each other. Whoever may glance at a specimen or figure of a similarly preserved trunk of a *Plesiosaurus*, from the old type *Ples. dolichodeirus* of Conybeare, now in the British Museum (Trans. of the Geol. Soc., 2nd Sec., vol. i., pl. xlviii.), to the *Ples. homalospondylus* of my last Monograph on the subject (vol. for 1865 of the Palæontographical Society, tab. v.), will appreciate the generic character of the ribs in the New Zealand fossil. They are robust, subcircular in section, expanding somewhat, or thickening, at their middle, obliterating there, or leaving very little of intercostal space, at least in the collapsed condition of the chest: they are, likewise, solid (as indicated by the representation of a fractured end).

The extent, in a straight line along the mid-part of this costal series, is about 18 inches. The extent of vertebral column to which they have been articulated may be reckoned, accordingly, to have included twelve vertebræ, averaging an inch and a half in length.

Now, this is the fore-and-aft diameter of each of the five consecutive cervical centrums figured at the fore part of the costal series. If the foremost is rather shorter, the hindmost proportionally gains; but the increase of breadth is more marked than that of length, as is usual at the base of the cervical series in *Plesiosaurus*. The diagrammatic character of Dr. Hector's drawing—perfectly trustworthy in reference to general form and dimensions of the bones—leaves me in some doubt whether the riblets be indicated by the fractured anchylosed bases, or by pleurapophysial articular surfaces. In either case, these elements projected from the low level of the centrum, as in the single vertebra, Figs. 1-3. The foremost vertebra, represented in the sketch, from which the proportion figured in Plate III., Fig. 5, is reduced, is a cervical seen from an oblique side view, showing that the pleurapophysis is anchylosed, and its expanded end —if it had an expanded end—has been broken of. But the difference in the fore-and-aft as compared with the transverse diameter in each of the eight cervical vertebræ in the sketch—there are two intervening between the consecutive five and the detached one—forbids my referring the single vertebra (Figs. 1–3, Plate III.) to the same species as those represented by Fig. 5.

If no other indications of an enaliosaurian reptile had been obtained from the Triassic (?) beds of Nelson Province, or from the Waipara beds or boulders, the part of a limb-bone—I believe femur—sketched by Dr. Hector, and of which a reduced view is given at Fig. 4 and 4*a*—would have sufficed.

It shows the hemispheroid articular head, coarsely pitted by the characteristic circular depressions, with slightly raised margins. The degree of contraction of the shaft to the broken and the indicated retention, so far, of a subcylindrical shape of shaft, are incompatible with any known modification of an Ichthyosaurian humerus or femur. These are more angular, and transversely oblong at the proximal end, and more rapidly compressed and expanded towards the distant one in the fish-like sea-lizard. The fragment of limb-bone, in the Museum at Wellington, is plainly plesio- or plio-saurian, and most probably part of the same species, if not individual, as the trunk sketched in Fig. 5. The long diameter of the head of the bone is 3 inches, 6 lines; the short diameter is 3 inches. The peripheral contour is flatter or less convex on one side than the other, as it is in the same part of the femur of *Pliosaurus portlandicus* (Monograph, in the volume for 1869, of the Palæontographical Society, tab. iv., fig. 3), in which the small crateriform pits of the articular surface are shown; but this character is common to *Plio-* and *Plesio-saurus.*

Other genera of Mesozoic saurians are suggested by the "List" drawn up by my friend, the explorer of this dangerous but richly-stored locality: but the difficulty of precise determination from outline-sketches, even as to whether an obviously cup-and-ball vertebra be "pro-" or "opistho-coelian," decides one to wait, for the present.

PLATE III.

Plesiosaurus Hoodii, Owen.

Fig. 1. Cervical vertebra, end view.
„ 2. „ „ side view.
„ 3. „ „ under view. } Half nat. size.

Plesiosaurus crassicostatus, Owen.

„ 4. Proximal part of femur.
„ 4*a*. Articular end of femur. } One-third nat. size.
„ 5. Trunk-ribs and vertebræ from base of neck, one-sixth nat. size.

II.—ON THE AGE OF THE STRATIFIED DEPOSITS, WITH MAMMALIAN REMAINS AT CROFTHEAD, NEAR GLASGOW.

By JAMES GEIKIE, District Surveyor of the Geological Survey of Scotland.

(With Two Woodcuts.)

IN the GEOLOGICAL MAGAZINE for September, 1868, I described a section of Drift deposits which had been exposed in the cutting of the "Kilmarnock and Crofthead Extension Railway." If the reader refers to that paper he will find it stated that the Lower

Boulder-clay of the locality in question contains certain intercalated beds of clay, sand, and gravel which have yielded *Bos primigenius.* Quite recently the remains of the horse and the great Irish deer have been met with in the same deposits. In the present paper I do not mean to say more about the character of the stony clay which overlies the beds with mammalian remains. There can be no doubt whatever that it is truly Boulder-clay. But as I understand that several members of the Glasgow Geological Society have since visited the section, and, while agreeing with me as to the glacial origin of the overlying Till, have yet expressed an opinion that this bed is not in its natural position, but has slipped down upon the stratified deposits from the adjacent hill-slope, it may be well to point out how all the facts are against such a supposition.

1. The bedded deposits of clay, sand, and gravel do not differ in the slightest degree from similar intercalated beds of very common occurrence in the Lower Boulder-clay of the south-west of Scotland. Along the numerous stream-courses of West Lanarkshire, Ayrshire, and the neighbouring counties, abundant evidence on this head will convince the most sceptical. I may add that near to the bottom of the *Bos*-beds I obtained from finely laminated clay a few scattered stones, all well striated—the smallest not bigger than a walnut, the largest about the size of one's fist. Here again we have a repetition of phenomena common to the Boulder-clay of the west and east of Scotland. In the valley of the Tweed, for instance, we have alternations of tough yellow Boulder-clay with beds of gravel (often full of scratched stones), and considerable thicknesses of sand and laminated clay, which occasionally exhibit a few scattered erratic blocks and striated stones. The same appearances are repeated in the valleys of the Stinchar, the Ayr, the Doon, the Irvine, the Avon, the Clyde, and their numerous tributaries. There can be no doubt that these bedded deposits are truly intercalated with the Boulder-clay, for excellent sections, which the merest tyro will understand at a glance, frequently present themselves in flat undulating country where there cannot be any possibility of intermittent landslips having occurred.

2. Throughout the trappean district in the neighbourhood of Crofthead, and for many miles to the west, south, and east, the hill-tops and steeper hill-slopes are singularly bare of Boulder-clay, that deposit being only met with in the bottoms of valleys and sheltered hollows, and here and there sparsely scattered over the gentler hill-slopes.

3. The overlying Boulder-clay in the Crofthead section is only a continuation of the same deposit which, increasing in breadth as the valley widens to the south-west, creeps further up the gentler valley-slopes in that direction than it does where the valley contracts and the hill-slopes become steeper. Hence the position of the Boulder-clay in this valley is quite natural, and just what one would expect to find.

4. The underlying laminated clays, etc., are in places highly crumpled and contorted, and the foldings are so arranged as to show

that the force which squeezed and puckered them must have acted in a direction *down* and not *across* the valley. Moreover it is a fact that the similar intercalated beds of clay, sand, and silt, so commonly met with in the Lower Boulder-clay of Scotland, almost invariably show contortions in the same manner as here.

5. An examination of the slope of the ground above the spot where the mammalian remains were found, certainly does not favour the idea of a landslip having taken place. The accompanying section (Fig. 1), drawn on a true scale, will better show this than mere verbal description. I have represented here the original surface of the ground before the railway operations were begun, and the line of section crosses the valley a few yards below the spot where the skull of the great ox was got. From B to A the general slope of the hill-side is not more than 11°; and from A the hill continues to slope up at the same angle for a distance of 470 yards, to where the hill-top is reached at a height of about 725 feet above the level of the sea. At B the rock-surface suddenly dips down at a much steeper angle, and against this slope the stratified beds abut. The Boulder-clay which rests upon these deposits originally extended as far as *c*, but was subsequently removed during the progress of the railway cutting. Now if the overlying position of the Boulder-clay is supposed to be due to a landslip it will also be necessary to suppose that the Till in question has glided bodily down a long gentle slope of 11°, that it has performed this wonderful feat of agility without leaving behind it any portion of its substance, and that after toppling down the slope at B it has crept boldly on over the level surface of the *Bos*-beds for a distance of at least 150 feet![1]

6. As the Boulder-clay which overlies the *Bos*-beds at the place from which the section (Fig. 1) is taken is the same deposit as that beneath which the stratified clays, etc., re-appear some little distance further up the valley, it follows that, if at the former place the overlying position of the Till be due to a land-slip, then the same must be the case here too. Upon such a supposition we have to believe that the Boulder-clay has slid along a slope of 12° for a distance of 230 feet at the very least, or if we suppose it to have come from the flat hill-top then it must have glided along the same gentle slope (12°) for some 660 yards or thereabouts. After this it must have had sufficient impetus to carry it for a distance of about 230 feet over the nearly level surface of the underlying lacustrine deposits!

But the accompanying section (Fig. 2) will show more clearly the nature of the ground. The general slope of the hill-side, above the Boulder-clay terrace, *b*2, is, as I have just stated, only 12° for a distance of 660 yards to the highest point [725 feet above the sea], overlooking the valley at the place from which the section is taken. The slope is quite bare of Boulder-clay. At *b*2° a small patch of Boulder-clay is represented, which by this time may have been cleared away. It is only the tailing-off of the Boulder-clay which, as we follow it towards Shillford, creeps a little further up the southern slopes of the valley, but is there very thin.[1] No overlying Boulder-clay, however, occurs on this side of the valley as we approach the spot from which section Fig. 1 is taken. The slopes of the rock surface below the drift deposits, as shown in the two sections, are protracted from the angle formed by the sides of the valley, and the depth from the level of the railway to the rock thus obtained agrees closely with that ascertained from borings. If the reader refers to my former communication (Vol. V., p. 393) he will there find stated the evidence for the existence of the Boulder-clay underlying the lacustrine deposits, which is represented in the accompanying woodcuts (Figs. 1 and 2) at *b*1.

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[1] I have not represented much of the south-east slope of the valley, as I do not suppose any one will dream that the Boulder-clay has slid from that quarter.

Quite recently the railway operations were interrupted by a landslip. The lacustrine deposits had been so deeply cut into that the downward pressure of the superincumbent Boulder-clay forced the soft wet beds below to bulge forward, and I was told that the rail-road was squeezed up some six or seven feet. The navvies had only repeated what the stream had done before. It appears clear to me that Boulder-clay, resting on lacustrine deposits, once filled up the entire hollow from B to D. By and by the stream cut its way down through the Till and cleared it away from *c* to D. The underlying soft, wet silt, sand, and clay, now pressed down unequally by the Till (*b*2), yielded, and bulged up at C, where, of course, the stream gradually washed it away. Thus the Boulder-clay, I believe, is now at a slightly lower level than formerly. Similar landslips may often be witnessed along the river-courses in the west of Scotland. In the valley of the Calder Water (River Avon) for instance, at Calderbraehead, the river has cut its way down through a broad and gently sloping terrace of Boulder-clay into deposits of soft clay, silt, and sand, which, from borings, have been ascertained to be of great thickness. Now, just as in the Cowden valley, so here, the weight of the overlying Boulder-clay has forced the subjacent denuded and exposed deposits outward into the stream, which is rapidly carrying them away, and the result is that the surface of the ground adjoining the river is permanently lowered. Thus, neither in the case of the Cowden Valley, nor in that just mentioned, have the landslips been caused by the sliding forward of the Boulder-clay upon the stratified deposits, but by the undermining, displacement, and actual abstraction of the soft foundations on which the Boulder-clay rests.

I saw the section at Crofthead, in November last, in company with my friend and colleague Mr. Croll, and I shall only add that he was as much surprised as myself that any one could fail to see the truly intercalated character of the lacustrine deposits which have yielded the mammalian remains.

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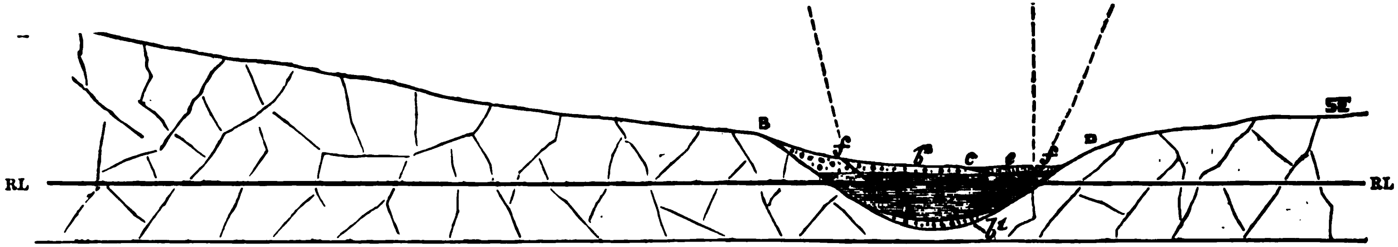
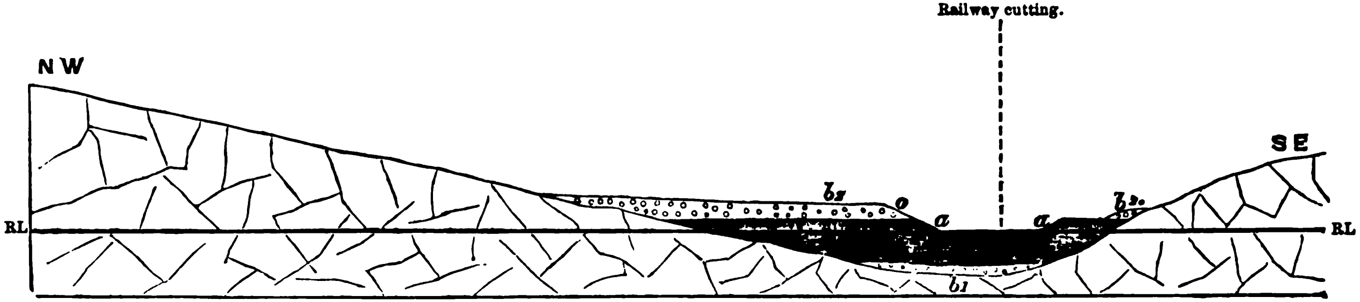
[1] If, therefore, I had taken the section (Fig. 2) across the valley, a little nearer Shillford, it would have shown a larger portion of Boulder-clay in the position represented in the annexed woodcut at *b*2*.



RL, Level of Railway, about 450 feet above the sea.

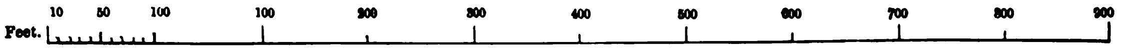
a, Lacustrine deposits with mammalian remains. b^1, Boulder-clay. b^2, Overlying Boulder-clay. *e*, Alluvium, &c. *f* to *f*, removed by railway operations.

(Fig. 2.) Horizontal Section (true scale) across the valley of the Cowden Burn, about 250 or 300 yards above the place where *Bos primigenius* was found.



RL, Level of Railway about 450 feet above the sea.

a, Gravel, sand, silt, and laminated clay (mammalian remains, got in these beds, further down the valley). b^1, Boulder-clay, position here inferred from combination of same section down the valley. b^2, Boulder-clay full of striated stones, seen at *o* in Railway cutting resting on stratified deposits. At b^2 the Boulder-clay is exposed in drains. At b^{2*}, a small patch of Boulder-clay.



Horizontal and vertical scale the same.

III.—CONTRACTION OF ROCKS IN COOLING. REPLY TO D. FORBES, ESQ., F.R.S.

By REV. O. FISHER, M.A., F.G.S.

IN replying to Mr. Forbes' strictures upon my paper at Cambridge upon "The elevation of Mountains, etc," I may be permitted to say, what would otherwise be of no consequence. The paper was read in April 1868. I received it back from the referees, accompanied by some valuable suggestions, in September. I was at that time much occupied, and did not work out those suggestions until January 1869. After having done so I wrote to Mr. Forbes, received his reply on the 29th, and a week later sent the paper back to the referees.

Although, therefore, as Mr. Forbes infers, the paper was altered subsequently to its being read, yet those alterations were not made without the sanction of the officials of the Society.

It seems to me that the more rocks contract in cooling, the more probable it is that the earth is solid. And I conceive that this must be a question of degree, unless we consider melted rock to be a perfect fluid.

I understood the same view to pervade Mr. Forbes's paper "On some points in Chemical Geology." Hence in quoting from his paper, in which he inclines to support the opinion of the earth's fluidity, I felt that I was not using data furnished by an advocate of the side of the question favourable to my theory; for that was based on the contraction of the earth in cooling. It was this, and nothing more, which prompted the expression, that Mr. Forbes was "concerned to reduce, as much as possible, the contraction of the materials of the earth." If the words *be* capable of a sinister meaning, I should have been ashamed to have used them in it.

The reply which I received from Mr. Forbes to my inquiry, whether he had allowed for the expansion of the iron moulds, was as follows:—"The expansion of the moulds was allowed for in many cases by measuring the *hot* moulds, which was easily done, since the moulds were in all cases cubes or rectangular. Other experiments were made both in stone and sand moulds. The results obtained by me are not put forward as representing the *true* amount of contraction, but as showing," in short, that Bischoff's results were considerably too large.

I did not alter what I had written because the qualifying words, "in many cases," led me to think (wrongly it appears), though hot moulds were in many cases used, yet that the dimensions given in the *Chemical News* were probably those of the moulds when cold.[1] This idea was confirmed by the disclaimer of exactness for the results. I am now sorry that I said anything about the condition of the moulds; for the sentence might have been just as well entirely left out. It was quite immaterial to my argument.

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[1] "The slags were allowed to flow into iron moulds, ten inches long by six deep and wide, also containing 360 cubic inches, a heavy iron top-plate being dropped upon them when overflowing, so as to ensure their being filled completely and evenly."—*Chemical News*, vol. xviii., p. 193.

As Mr. Forbes did not state in his paper in the *Chemical News* that the blocks of slag were devitrified as cast, it was surely pardonable in me to suppose the contrary, having been told of the slow process of cooling needful to devitrify the Rowley rag. And I do not even now feel convinced that a slag cooled thus quickly enters into the normal stony condition of an igneous rock.

Mr. Forbes does not find fault with the number 0·060, as expressing the final contraction of the Rowley rag. If that number be used in the place of 0·09, which I have employed, the only part of my paper that will be affected by it will be the rough estimate of the height of mountain chains, caused by a contraction supposed equal to the latter number. These will have to be lowered, in the ratio of 0·64 to 1, or nearly in that of two to three; and thus the results will be made to accord with nature better. But I must repeat the caution, that no attempt is made here to arrive at a definite result, because we have no right to assume that an upper shell of the earth, of the thickness I have supposed, has contracted to the same amount as the Rowley rag did, in passing from a fused to a devitrified state. Its contraction may have been less or it may have been greater. Yet I think we may assume that it has been of the same *order* of magnitude, which is all that I intend to assert. All that my general argument requires is the admission that heated rocks contract on cooling. It is not affected by the question whether the earth be *now* solid, or fluid, or semifluid, internally. If it be fluid, that condition will more easily explain volcanic action, though it seems possible the solid condition (to which I incline) may be compatible with my speculation as to its cause.

The somewhat lengthy investigation as to the condition of pressure in the interior, on the supposition that the earth is solid, is intended not to leave that case unprovided for.

Finally, a word for the mathematicians, of whom I make no pretension to be one. So long as certain questions cannot be touched without their aid, their vocation will be a needful and an honourable one. The present feud seems a re-enactment of the fable of the belly and the members. Mathematics has been likened to a mill. I will extend the simile, and call the mathematician, not the miller, but the millwright. The experimentalist is the grower of the corn. If the corn is good so will be the flour. But though bad corn be once put in, and bad flour come out, the mill is as good as ever; and so, if a false numerical result be introduced into a problem, the mere substitution of a correct one will bring a correct result. Few men can be accomplished on all sides, and the shortcomings of the mathematician, as an experimentalist, will best be met by kindly suggestions from his more accomplished fellow workers in other portions of the vast fields of science.

IV.—THE LIQUEFACTION OF ROCKS.

By Dr. T. STERRY HUNT, F.R.S.

THE number of *Scientific Opinion* for October 27 (page 457), contains a note by the Rev. Osmond Fisher, calling attention to a suggestion, with regard to the liquefaction of deeply buried rocks, made by him in a paper read before the Cambridge Philosophical Society in April, 1868, and since published in the Transactions of that Society. In a notice of this paper by him, in the GEOLOGICAL MAGAZINE for November, 1868, Mr. Fisher insists that deeply buried and intensely heated portions of rock, which, in accordance with the conclusions of Mr. Hopkins, are kept in a solid state by great pressure, may, by a diminution of pressure consequent upon movements of the earth's crust, assume a liquid condition, and thus give rise to lavas. This suggestion is however claimed by Mr. Scrope, in a communication to the same Magazine for December, 1868, as his own, and as having been put forward by him in both editions of his now classic work on Volcanos. This statement of Mr. Scrope was questioned by Mr. Fisher in the GEOLOGICAL MAGAZINE for January, 1869, and Mr. Scrope does not appear to have replied. In a paper in the same magazine for June, 1869, I have referred to this view as belonging to Mr. Scrope, and as also advocated by Mr. Fisher, who has availed himself of the republication of my paper in *Scientific Opinion* for October 20, to re-assert his claim to be the originator of this view, and to demand either of Mr. Scrope or myself some justification of our assertions.

I might leave to Mr. Scrope the task of vindicating himself, and rest, so far as I am concerned, upon his statement in the GEOLOGICAL MAGAZINE for January, 1868, but having before me Mr. Scrope's book on Volcanos (edition of 1862), I venture to call attention to a passage therein, which has probably escaped Mr. Fisher's notice, where Mr. Scrope concisely speaks of "the extravasation and ebullition of subterranean mineral matters (known, so far as we are acquainted with them, to contain water), which *increased temperature* or *diminished pressure* has liquefied and caused to effervesce" (page 309). Elsewhere he speaks of the imperfectly liquid condition of the matter underlying a volcanic vent, as varying from time to time "according to *circumstances of temperature and pressure*," and proceeds to show that "*changes in position, bulk, weight, cohesion, and consequent resistance of the rocks above*" are to be considered, as well as the variations in the rate of heat from below (page 266). These passages, in which I have italicised certain words, will, I think, establish Mr. Scrope's claim of priority over Mr. Fisher, whose excellent memoir has merits enough, which are wholly his own.

According to Mr. Scrope's view, rocks may be melted either by increase of heat or by diminution of pressure, and congealed by diminution of heat or by increase of pressure. This would, doubtless, be the case if the simple igneous fusion of anhydrous rocks were in question; but admitting, as I do with Mr. Scrope, that the rocks involved in these processes all, so far as we know, contain water, there probably intervenes, as I have elsewhere endeavoured to show, a different law. As explained in a paper on the probable seat of volcanic action (GEOL. MAG., June, 1869), I regard the liquidity of the stratum in which I place the seat of volcanic agency as due, not to simple igneous fusion, but rather to an igneo-aqueous fusion, as maintained by Scrope, Scheerer, and Elie de Beaumont, where water at a high temperature, aided by pressure, produces a *quasi* solution. As I have there endeavoured to show, pressure, which in the first case, that of simple fusion of anhydrous materials, prevents liquefaction by preventing expansion, in the second case, on the contrary, favours liquefaction by promoting solution of the water-impregnated mass. As Sorby has shown, a conversion of mechanical into chemical force appears in the increase of solubility under pressure. In other words, pressure prevents fusion when, as in most instances, it is a process of expansion, but favors solution, which is, with few exceptions, a process of contraction. Now since I place the seat of volcanic action in a region where solution, rather than simple fusion, is the cause of liquidity, I am led to regard pressure as one of the efficient causes of the liquefaction of rocks, and to regard its diminution as leading to solidification. This conclusion, though in contradiction to the letter of Mr. Scrope's teaching, will not, I venture to hope, be rejected by the master who first taught us the true cause and nature of the liquidity of lavas.

MONTREAL, *December* 7, 1869.

V.—OBSERVATIONS ON THE SEQUENCE OF THE GLACIAL BEDS.

By S. V. WOOD, JUN., F.G.S.

PART II.

(Concluded from the January Number, page 22.)

Turning now to the physical evidence, it is well known that the Moel Tryfaen bed is 1390 feet above the sea-level; and a depression which would bring the sea up to that point would, unless we suppose a great change in the relative elevations, place the Chalk many hundreds of feet beneath the sea.

The Middle Glacial beds, which are chiefly composed of chalk flints in the East of England, are also largely charged with the same material, as far as I have traced them into the Oolitic, the Liassic, and even the Triassic districts; and they never, so far as I have traced them, rise to elevations exceeding 420 feet, which is near Rugby. In East Anglia they usually cease between 200 and 250 feet, the bed *e''* overlapping them, and extending up the higher elevations; but in one instance (Danbury) they seem to go to the height of 360 feet. They occur at all less elevations, down to and below the present sea-level. It is difficult to imagine, in the face of this, that all the Chalk could have been below the sea-level during the formation of the Middle Glacial; at any rate, it could hardly have been depressed to an extent sufficient to bring the sea up to the 1390 feet level.

More important than this, however, is the fact that the Middle Glacial is overlaid by the great chalky clay (*e''*) which forms the largest member of the whole series, both in thickness and extent, covering the chief parts of many counties, and possessing a thickness that seems, before denudation reduced it to all thicknesses, to have generally been 100 feet, and sometimes to have much exceeded this.

During the accumulation of the whole of this clay the Chalk was undergoing its icy degradation, and when, therefore, it is scarcely probable that the land could have descended to such a depth as would bring the sea up to the Moel Tryfaen level. And more especially does this appear in the fact that from a section of this clay, overlying the Middle Glacial, I obtained a piece of the Red Chalk that nowhere[1] rises to elevations exceeding 300 feet, and is usually much lower. So far as its bearing upon the relation of the underlying Middle Glacial to the Cheshire and Moel Tryfaen beds is concerned, this occurrence of lumps of red chalk at the base of the great chalky clay is as significant as if it occurred at the top.

It therefore appears to me, as clear as anything connected with this difficult subject can be, that the Moel Tryfaen bed must be posterior to all the beds from *h* up to and inclusive of that wherein the Chalk begins to disappear, viz., *e'*; because the Molluscan evidence, as far as we have really got at it, and the physical evidence go hand in hand together without a contradiction.

How far this Moel Tryfaen bed may be identical in time with the bed *e*, a clay formed without any contribution from the Chalk (and, as it appears to me, under a great submergence that had engulfed the Chalk strata beyond the reach of the degrading envelope of ice), I venture not to say; but as the period of the greater emergence, to which I have before adverted, can scarcely have been other than of long duration, there seems ample scope for placing the Moel Tryfaen and Macclesfield sands in it in the order of their relative levels; the highest being the oldest, and the lowest the newest. Nor does there seem to me to be anything in the evidence offered by Mr. Darbyshire's lists that is repugnant to this, such difference as exists between the fauna of Moel Tryfaen and that of the Cheshire beds rather favouring it; the fauna of the highest bed, that of Moel Tryfaen, departing somewhat less from the Arctic character than the others. In this point of view they would seem to belong to the group *d*; none of them to the newest of that group, and Moel Tryfaen among the very oldest.

There seems, however. some dispute as to the position of the Cheshire and Lancashire fossiliferous sands relatively to the Boulder-clay of those counties, some Geologists regarding them as identical with the sands which intervene between the Boulder-clays—or, perhaps, intercalated in the Boulder-clay—of that part, and some not. If that identity do exist, I have, I think, pointed out enough to show that none of them can have any connexion in time with the Middle Glacial of East Anglia; but if, on the other hand, they be not identical, the question then arises, how far this middle sand of Cheshire and Lancashire offers grounds of identity with the East Anglian Middle Glacial.

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[1] I think that this holds good even if we suppose the fragment to have come from one of the pink bands of the true chalk.

In the first place it behoves us to bear in mind that when we find at Kelsea a gravel and sand whose fauna, as a group, offers nothing that, on the one hand, would serve to identify it with the Middle Glacial, or, on the other, with the Moel Tryfaen and Cheshire fossiliferous sands, overlaid in actual section by a clay (that of Hessle) which, though containing Boulders (and striated ones, too), is, as it seems to me, obviously unconnected with the Glacial series, that is, with the beds belonging to the great subsidence, there is no *primâ facie* reason that sands should be identical with the Middle Glacial of East Anglia merely because they intervene between two Boulder-clays, or are intercalated in a Boulder-clay, as the case may be. Beyond its bearing on any such *primâ facie* assumption, there is no need to allude further to the Hessle clay, for I have seen no reason as yet to suppose that it is represented in the north-west of England, though such may be the case.

If it be the case, however, as Mr. Mackintosh represents,[1] that the Lower Boulder-clay of Lancashire reaches up to elevations of 1,200 feet, then it is difficult to conceive that there can be any identity between this clay and the beds, *g* and *h*, forming the East Anglian Lower Glacial, for the following reasons:—The organic remains occurring in, as well as the structure and distribution of the beds, *h*. indicate that the little elevated counties of Norfolk and Suffolk were only partially submerged during their accumulation; while the bed, *g*, nowhere reaches higher than 250 feet. The marly portion of this bed, *g*, being formed of the material of the soft chalk of Norfolk, Suffolk, and the adjoining counties, ground down by ice, and spread out in a nearly pure state under water, and the brick-earth portion of it enclosing huge masses of the same marl, introduced by the agency of bergs, proves that such chalk was not sufficiently submerged at this time to be beyond the reach of the degrading action of the icy envelope. The principal part of the chalk so supplying the material of *g* does not lie at one-fifth of the elevation thus reached by the lower clay of Lancashire, and even its highest eminences fall hundreds of feet short of that elevation; and we can, therefore, scarcely suppose such a deposit as *g* to be coeval with the lower clay of Lancashire, possessing the range in elevation which is assigned to it. To suppose this Lancashire clay to have been formed by land ice would not help the matter; because the 1,200 feet elevation must have been reached by the sea before such ice as that to which the Glacial beds are due could be arrested, so as to form a moraine. But, indeed, the difference between *Glacial*[2] clays, due to land ice, and those due to marine deposit, is more nominal than real; for all of such clays appear to me to be due—as Mr. Archibald Geikie has, in the case of Scotland, pointed out—to the vast moraine[1] which was extruded from the submerged foot of that icy envelope, whose termination, during the Glacial period, as it is now in West Greenland, was never short of the sea. Such moraine, either rafted away to form the clays, or its soluble and finer portions taken up by the water and carried away in suspension, and its insoluble spread out by the currents to form the sands and gravels, seems, according to my apprehension of the case, to have supplied the whole of the beds of the true Glacial series, that is, those formed during the subsidence, except, perhaps, the very earliest—the pebbly sands, and even those partially so; the whole series being thus (but with one considerable alternation of the contrary kind between *g* and *f*) retrogressive in their character, as the moraine followed the ice in its recession from the action of the sea during the progress of the subsidence.

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[1] Quart. Journ. Geol. Soc., vol. xxv, p 430.

[2] With *Post-glacial* beds, when the Glaciers were arrested before they reached the sea, the case is different; and beds due to land ice, in their true sense, may *then* have accumulated, and at high elevations.

All that has been written of the Lancashire and Cheshire Drift, and of the Mollusca from it, since it was described, in its general features, by Mr. Binney in 1842,[2] and by Mr. Trimmer in 1846,[3] leaves the impression on my mind that none of it belongs to any older part of the Glacial series than the beds, *e,″ e′*, and *e*, though I would not be understood as asserting a positive opinion that such is the case.[4] The existence of two Boulder-clays divided by a sand, whether shown by isolated, or visible in repeated sections over a considerable space, seems to me illusory, so far as it offers any ground of correlation, because along the Yorkshire coast, north of Bridlington, the purple clay without chalk (*e* of the Table) is divided into two parts by sand beds, often of considerable thickness, which, though not actually continuous, are of such length and frequency that inland sections would convey the idea that they formed a continuous deposit. So also along the great Vales of York, and of the Tees' mouth, a bed of sand, apparently continuous, in places divides a lower from an upper Boulder-clay. Whether this upper clay be the Hessle, and this sand the bed, *c*, or not, neither the latter nor the sand so threading through the purple clay along the coast can, according to my apprehension of the case, have any connexion whatever with the Middle Glacial of East Anglia, the Boulder-clay upon which these sands rest belonging, as it seems to me, to the beds *e* or *e′*, according as their position occurs.

With respect to the beds of Aberdeenshire, described by Mr. Jamieson in 1858,[5] to which Prof. Harkness refers, I think that we should, for the present, suspend our judgment as to an identity between them and the East Anglian Middle Glacial, until a question of identity between these beds and another described from the same neighbourhood by Mr. Jamieson in 1860,[1] under the name of Crag, is answered. The shells from this last mentioned deposit were submitted by Mr. Jamieson to my father at the time, and as it had not then been decided that *Tellina Balthica* (*solidula*), which was among them, was not a Crag shell, and as the rest of the shells were Crag forms, and especially as they comprised *Nassa reticosa* var-*rugosa*, it was reasonable that both Mr. Jamieson and my father should, as they did assign them to that formation.[2] The presence of this *Tellina* is regarded by my father now and by myself as conclusive proof of the Glacial age of this bed; and there seems every probability, from the combined circumstances of its being a stratified, sandy gravel, in which flints are common; of its underlying Boulder-clay; and of its containing, not merely *Pectunculus glycimeris* in abundance, but also, with the exception of this *Tellina*, exclusively Crag forms, that this deposit is the East Anglian Middle Glacial.

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[1] I use this term moraine for convenience, but in strictness there is little or no identity between the *sub*-glacier degraded material thus extruded and the *supra*-glacier collected material, which forms the principal part of the true Alpine moraine.

[2] Proc. Manchr. Geol. Socy. 1842-3. [3] Quart. Journ. Geol Soc., vol. vii., p. 201.

[4] The great addition, however, made to the fauna of the Middle Glacial formation since this paper was in type, seems to place this beyond question, and to prove that the Cheshire and Lancashire beds are all newer than this formation.

[5] Quart. Journ. Geol. Soc., vol. xiv., p. 509.

Whether the beds so described in 1858, and embraced by Mr. Harkness in his identification, can now be made out to be identical with the bed of 1860, it is for Mr. Jamieson, or others who are able to study them on the spot, to determine; for Mr. Jamieson, in describing these supposed Crag sands, confines them to two parishes only out of the extensive tract, thirty-five miles in length, described in 1858, and distinctly negatives any identity between them and the principal part of the beds of the Aberdeenshire coast. I think, therefore, that we are bound to suspend our judgment on the age of these 1858 beds until this point is cleared up.

The magnitude of the Middle Glacial formation may be best illustrated by saying that the formation extends (but mostly covered by the clay, e'') over nearly all of the three large counties of Norfolk, Suffolk, and Essex, besides its ramifications into the more central counties; and there is some reason, I think, to believe, as I pointed out some years ago, that it spreads, under the name of *Sables de Campine* of A. Dumont, over a large portion of Belgium and the parts of Europe contiguous thereto. A good idea may be formed of its mass and extent by the line of railway from Colchester to beyond Woodbridge, throughout which distance the cuttings almost exclusively traverse it. Those who hunt for fossils in the Red Crag will find that formation, wherever the denudation has not descended too low, overlain by it.

I have expressed, in papers read before the Geological Society, an impression that I entertain, derived both from physical and palæontological evidence, that the Glacial beds of the North of England are all newer than the Middle Glacial of East Anglia, and it seems to me that, with the exception of the Aberdeenshire beds, already referred to, the Scotch beds, Boulder-earth, Boulder-clay, and stratified beds, called, though of different ages, all Glacial, from the presence of many arctic shells, are all, or nearly all, of the same later age, and belong, some to the series c'', c', and c, and the rest to the earlier part of the still later stage, which, for convenience, I call *Post-glacial*,[1] that is, to the period of the great emergence, or to the earlier part of that which succeeded it in the north, such as the beds *b* and *c*.[2]

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[1] Quart. Journ. Geol. Soc., vol. xvi., p. 371.

[2] They also yield *Nucula Cobboldiæ* and *Voluta Lamberti*. Quart. Journal Geol. Soc., vol. xxi. p. 162.

The Caithness beds, brought also by Mr. Harkness into identity with the East Anglian Middle Glacial, seem to offer no points whatever to support any such conclusion. It is the opinion of their latest describer, Mr. Jamieson,[3] that, while they contain a mixture of species from Glacial beds of earlier and later date, they belong all of them to the later part of the Scotch series; and, assuredly, there is nothing in the fauna yet described from them which would admit of their being regarded as of similar age to that bed, described in 1860, as Crag, which seems to me to be the Middle Glacial.

As I propose, at a future time, to endeavour to shew the grounds for this opinion as to the relatively newer age of most of the Scotch beds, I shall not allude further to them here than to observe that in none of the Scotch beds, except that of Aberdeenshire, before referred to, which contains one of them, have there yet occurred such shells as the well-known Crag forms—*Tellina pretenuis*, *Tellina obliqua*, *Cardita scalaris*, and *Nucula Cobboldiæ*. Of these, *Tellina pretenuis* occurs in the East Anglian Lower Glacial. *Tellina obliqua* occurs in the same, and also in the Middle Glacial, and at Bridlington. *Cardita scalaris* occurs in the Middle Glacial, and *Nucula Cobboldiæ* both in the Lower Glacial and in the Upper (Bridlington).

All these four shells were, until recently, regarded as extinct. The two first are still unknown living. *Cardita scalaris* has recently been identified, by my father, with *Cardita ventricosa* of Gould, from the American North Pacific coast, and *Nucula Cobboldiæ* is either extinct or else identical with another Pacific shell, *Nucula Lyalli*.

With those who attach more importance to a list of shells *simpliciter* than I am disposed to do, these shells should have much weight; for though *Tellina obliqua*, regarded by most palæontologists as a species, was looked upon only as a variety of *Tellina calcarea* (*proxima* or *lata*) by Edward Forbes, and described as a synonym of that shell in Forbes and Hanley's Mollusca,—a view lately adopted also by Mr. Jeffreys,—it is unknown living. Whether a variety or a species, however (and these terms appear to me matters of degree and not of kind), the shell is of equal, and indeed, from its abundance in most deposits where it exists, of greater, *geological* value than most so-called species; for it is one of the best marked types of the upper Crag occurring in the newer part of that formation, the Chillesford, in riads, in association with almost as great a profusion of *Tellina* *area* and *Tellina pretenuis*, the three forms being always distinct. the Lower Glacial, though *Tellina pretenuis* becomes somewhat e, and has not yet occurred higher in the series, the other two, *lina obliqua* and *Tellina calcarea*, occur in abundance in that nation, and also maintain themselves together in the Middle cial, and even into the Upper; while *Tellina calcarea*, an existing tic shell, alone occurs in the Scotch beds. *Tellina obliqua*, having g preceded *Tellina calcarea* in existence, for it occurs in the alline Crag, thus preceded it in extinction.

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[1] It will have appeared from the earlier part of this paper that I use the term *Post-glacial* in a very different sense from that in which it is used by the Scotch Geologists.

[2] This seems also to have been in some degree the opinion of the late Dr. Woodward, judging from the last five lines of his paper on the Bridlington fauna. Geol. Mag., Vol. I., p. 52.

[3] Quart. Journ., vol. xxii., p. 280.

onversely, *Mya Uddavallensis*, one of the most conspicuous types the beds of the Clyde basin, occurring also in the Caithness lder clay, and not known living nearer than Canada, is unknown ll the English Glacial series older than *e*; but it is mentioned by . Leckenby[1] as having been found by him in the chalkless purple y of Scarborough cliffs, which Mr. Rome and I refer to the similar lkless clay, *e*, which caps the clays with chalk in the Holderness fs.

These circumstances seem to indicate that while such of the tch beds as yield this *Mya* approximate in time nearer to the west of the English Glacial series (the clay *e*) than to any other, ne of the beds of this part of Britain, except the one in Aberdeenre, (and such extensions of it as may prove to exist,) and perhaps s at Kilmaurs in Ayrshire, described by Dr. Bryce,[2] belong to r older part of the series than the Upper Glacial, *e''* *e'* and *e*.

The close analysis which the subject requires will I trust excuse length to which this paper has extended.

NOTE.—Since the foregoing paper was written, I have, with the istance of Mr. Harmer, largely augmented the list of mollusca m the East Anglian Middle Glacial. The number, exclusive of eral that cannot be reliably identified by reason of the obscurity the fragments, is now 56. The specimens have been studied d compared with great care by my father; and one of the shells, *Mangelia*, appears to be quite new, while another differs sufficiently m *Mangelia linearis* as, perhaps, to necessitate its separation. ith the exception of these two, and of *Tellina Balthica*, the whole Coralline, Red, or Fluvio-marine crag forms; and include *llina obliqua*, *Nucula Cobboldiæ*, *Nassa granulata; N. reticosa* var *tata Purpura incrassata*, *Turritella incrassata* (this in profusion), *rdita scalaris*, and other extinct forms. The fauna presents great similarity from that of the Lower Glacial pebbly sands, on the one nd, and from that of Bridlington, on the other; while it possesses affinity with any of the following, viz., Blackpool, Moel Tryfaen, cclesfield, Severn Gravel, Kelsea-hill, Glacial beds of East of tland, or the Clyde beds. On the other hand, all the peculiarly g shells, enumerated by Mr. Jamieson from the Aberdeenshire rag gravel" of 1860, except *Voluta Lamberti* (and that even I re reason to believe has occurred in it), are among this 56. The na is clearly not derivative, and it has a preponderatingly

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Geo. Mag., Vol. II., p. 347.

[2] Quar. Jour. Geol. Soc. vol. xxi., p. 216.

Southern aspect. The details will be given in my paper "on the relation of the Boulder-clay of the North of England to the great Chalky clay of the South," when published in the Quarterly Journal of the Geological Society.

VI.—On the Millstone Grit of the North Wales Border.

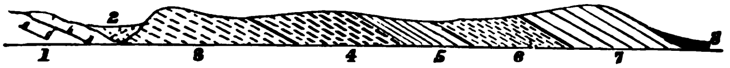
By D. C. Davies, Oswestry.

THE Millstone Grit of the North Wales Border follows the eastern slope of the Carboniferous Limestone, from Crickheath and Sweeney, South of Oswestry, to the shores of the Irish Sea; it is also thrown up into the range of hills which the traveller by the Great Western Railway may see to the west of the line between Oswestry and Chester. This range serves as a natural boundary between this part of England and Wales, and forms a second line of natural fortification, strengthened on the English side by numerous outposts of low hills of clay, gravel, and sand, which give place, upon the Welsh side, to precipitous escarpments of Mountain Limestone, beyond which the change in the language, dress, and manners of the people is marked and sudden.

These hills are composed for the most part of an accumulation of sandstones, of very variable superficial breadth, affected as that breadth has been, firstly, by the area of their original deposition; secondly, by the amount of denudation they have since suffered; thirdly, by the extent to which they are covered by the Coal Measures; and fourthly, by the disturbances which have elevated the sandstones and the Coal Measures, leading to the subsequent denudation of the latter from off their surface. Thus, in the southern half of its course, say, from a point south-west of the town of Wrexham to Sweeney, the Millstone Grit presents the appearance of a continuous band of variable breadth, while, in its northern continuation, through a country crossed by numerous faults, it appears in disjointed patches, among the Coal Measures, as well as in a main band following the course of the Limestone towards Mold, Holywell, and the sea.

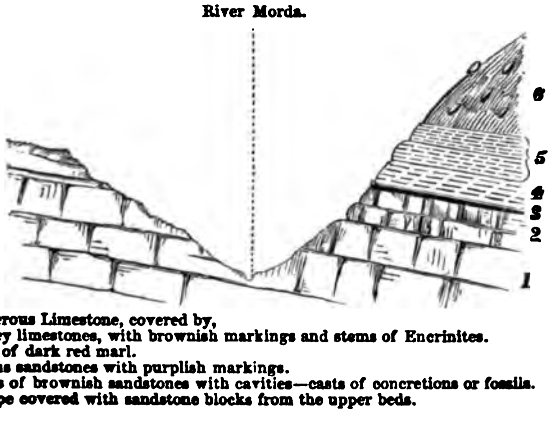
By the construction of a branch line from the Cambrian Railway, a most instructive section of the Grit has been exposed at Sweeney, perhaps the most complete hitherto obtained. By a reference to this section (See Woodcut, Fig. 1) it will be seen, that above the main body of Carboniferous Limestone there rests a deposit of coarse red and purple Sandstones, containing layers of pebbles; this is followed, in ascending order, by a considerable thickness of Calcareous Sandstones, containing in places thin layers of limestone, and these in their turn are overlain by a series of yellow, mottled, and brown beds; the whole being capped by a deposit of pinky-white sandstone, becoming in places pure white. Unfortunately, in this section the junction between the Grit and the Limestone is not seen, owing to a covering of drift, but if we travel a little towards the north-west we find, first, at Treflach, the deep red sandstone beds passing downwards into a purplish calcareous sandstone; and, in Craigfords wood, we find the junction of this with the limestone proper (See Woodcut, Fig. 2). The section, however, which best illustrates this point, is seen in a small and comparatively unknown quarry at Carreg-y-big, 3½ miles north of Oswestry (See Woodcut, Fig. 3), where we have at the base the limestone proper, which is here burnt for Agricultural use, and at the summit thin sandstones of the Millstone Grit. It will thus be seen, that the change in the character of the deposits, while it was somewhat gradual, was, in the southern part of the area in question, marked and permanent. There were temporary cessations of the supply of calcareous matter, at various periods during the deposition of the Carboniferous Limestone, as is evidenced by four or five well-marked ferruginous shaly beds in the lower, and of bituminous shales in the upper portion of that formation; the supply of calcareous matter became subsequently less and less, and, with the exception of an unimportant outflow in the middle beds, permanently ceases. These remarks are however only applicable to the southern half of the area, as I shall have occasion to explain presently.

FIG. 1.—Section of Millstone Grit at Sweeney, 2½ miles South of Oswestry.



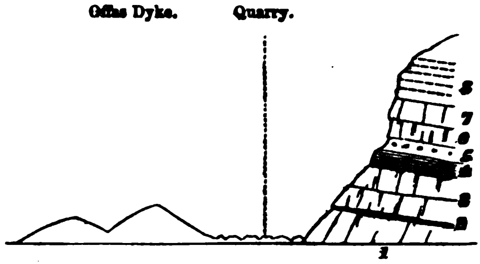
1. Carboniferous Limestone: *Productus*, *Lithostrotion*, and usual fossils of the top beds.
2. Covering of Drift, hiding the junction of the Limestone with the Grits.
3. Yellowish ferruginous sandstones, massive dark red ditto with coarse pebbles. Fossils in some of these beds; Corals, uncertain species; *Rhynchonella*, *Sanguinolites*, *Metoptoma*, *Chonetes*, *Productus semireticulatus*, *P. cora*, etc., etc.
4. Calcareous sandstones, about 60 feet.
5. Soft, white, buff, mottled, and striped sandstones, with thin beds of marl and shale. *Schizodus* in some of these beds.
6. Fine-grained hard pale sandstones, with occasional layers of pebbles, and, in the fine beds, reticulated plant and annelide-markings.
7. Beds of friable sandstone, passing upwards into solid beds of pinky-white sandstones, with lateral pockets, capped with thin beds dipping under the Coal Measures. *Productus semireticulatus* in great abundance, large *Orthoceratites*, *Calamites*, and fucoid remains. Total thickness of Grits between the Carboniferous Limestone and Coal Measures, 282 feet.
8. Coal Measures.

FIG. 2.—Section showing the junction of the Millstone Grit with the Carboniferous Limestone, in Craigforda Wood, 3 miles N.N.W. of Oswestry.



1. Carboniferous Limestone, covered by,
2. Light grey limestones, with brownish markings and stems of Encrinites.
3. Thin bed of dark red marl.
4. Calcareous sandstones with purplish markings.
5. Thin beds of brownish sandstones with cavities—casts of concretions or fossils.
6. Steep slope covered with sandstone blocks from the upper beds.

FIG. 3.—Section showing the junction of the Millstone Grit with the Carboniferous Limestone, at Carreg-y-big, 3½ miles N. of Oswestry.



	ft.	in.
1. Massive grey limestone, base not seen.		
2. Dark grey shale	0	6
3. Grey limestone with shale	2	2
4. Yellowish brown clay	1	6
5. Concretionary limestone	0	6
6. Limestone abounding with encrinite stems	1	0
7. Purplish grey arenaceous limestone, becoming sandy towards the top	2	3
	7	11
8. Thin purplish sandstones, Millstone Grit.		

As might be expected, the sandstones are of various degrees of texture, ranging from fine to coarse-grained, whilst layers of pebbles—varying in size from a pea to an egg—are present in both the lower and upper portions of the group, the calcareous sandstones in the middle being most free from them. All this I need scarcely say is owing to, and denotes the different depths of water in which the whole series was deposited,—from the strong current (tidal or otherwise)—and shallow water in which the pebbles were rolled, to the still depths in which the fine grains of sand quietly sank. Both the larger pebbles and the finer sand are of quartz, in its different varieties; and although I have examined many blocks of sandstone for the purpose, I have been unable to detect a fragment of limestone, and but rarely any traces of the older slaty and porphyritic rocks of Wales. Both pebbles and sand are, as stated by Sir R. Murchison, in his "Silurian System," cemented together in a paste of felspar, but the distribution of the felspar is very unequal. Thus, in the uppermost beds of the section at Sweeney, we find considerable layers of felspathic clay, succeeded by thick beds of sand, in which it is scarcely present, and some even from which it is totally absent, the sand simply cohering from surrounding pressure, and when this is removed becoming loose sand (white generally), which can be dug out, as it is sometimes, and used in mortar. The various beds are also coloured by metallic oxides, peroxide of iron being largely present in the deep red beds, manganese in the speckled, and copper here and there giving a greenish tinge, as at Sweeney and Trevor.

In the 8-feet bed, near to the top of the Sweeney section, there are some curious "Pockets," which illustrate both this unequal distribution of felspar, and the varied colouring of the rock. These Pockets differ from all those I have hitherto observed or seen described, in that they are horizontal, and not perpendicular, extending laterally into the rock, not simple vertical cavities on its surface. I give a representation of some of these (See Woodcut, figs. 4–7). At first sight they bear some resemblance to the concretions which are so abundant in the Wenlock Shale of North Wales, but there is this difference, that whereas the Wenlock Shale examples are concretions of a harder nature than the surrounding rock, and are formed around a crystalline central nucleus, or cavity, filled with crystalline matter, these in the Grit are cavities with no perceptible outlet or inlet, filled with loose brown sand, gathered around a nucleus of white or yellowish clay, the surrounding rock being nearly white. Around the outer margin, as in figs. 4 and 7, there are dendritic markings; and sometimes, as in figs. 6 and 7. dark lines of mineral matter enter the surrounding rock.[1]

Pockets in the Millstone Grit at Sweeney, near Oswestry.

Fig. 4. Fig. 5.

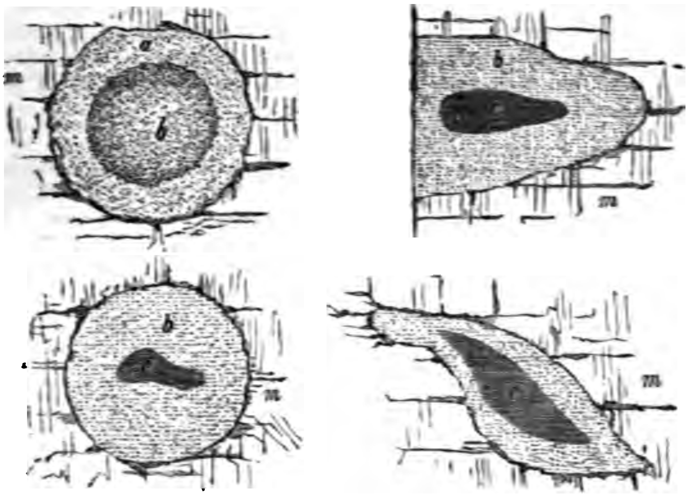


Fig. 6. Fig. 7.

Fig. 4. Front view of Pocket, 2 feet 6 inches in diameter, with marginal rim (*a*) of dendritic markings of manganese, and centre (*b*) of yellow sand.
5. Side view of the same Pocket, showing the comparative depth to which it penetrates the rock *m*, (*c*) central nucleus of felspathic clay.
6. Front view of another Pocket, with end section of central nucleus of yellow clay (*c*) and radiating lines of manganese.
7. Front view of irregular shaped Pocket, with ochreous centre (*c*) and dark variegated margin with dendritic markings. (*m*) matrix of pinky-white sandstone, bed No. 7 of Fig. 1.

My description of the beds so far has been drawn principally from the sections south and west of Oswestry, but in many respects it holds good of the formation generally. There are, however, local variations, as might be expected, arising from local causes, which affected the original mode of deposition; as, for example, the degree of intensity of the currents, and the nature and amount of the materials. It may therefore be interesting to note a few of the local changes that occur as we follow the formation northwards from Sweeney. At the southern end of Cyrn-y-broch, north-west of Oswestry, the beds corresponding to the upper 26 feet of the Sweeney section are changed in colour to yellow, and become in their upper portion very cherty and splintery. The uppermost beds, seen in a quarry on the right of the road from Oswestry to Llansilin, near the Racecourse, become flaggy, and are covered with well-defined ripple marks. In the Forest quarry, on the north-west side of the Oswestry Racecourse, there is a bed corresponding with the pale hard fine-grained sandstone of Sweeney, which becomes very coarse and pebbly, and contains in its finer portions well-defined crystals of felspar. Over this there is a bed, one foot thick, which is literally an agglomeration of pebbles, covered by an irregular deposit of sand, pebbles, and sandstones, about 3 feet thick.

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[1] It is difficult to account for the origin of these Pockets, and it is with diffidence that I venture to offer the following suggestion, viz.: That in the centre, where we now find the clay, there was originally a concretion of mineral matter; next, by electro-chemical agency, such as is supposed to have aided in the formation of some mineral veins, this mineral matter was disseminated around to the boundary of the present pocket, and the felspathic clay—the cementing matrix of the rock—concreted into the central cavity thus made by the dispersion of the mineral base, leaving the sand, which had become discoloured by the dispersion of the mineral matter, simply cohering by the force of the surrounding rock.

Section of Millstone Grit at Trevor, near Llangollen.

[This section was kindly given to me by the Messrs. Roberts, of Garth Quarry, Trevor, from a record of borings made below their quarry, in the 78ft. of Sandstone at the head of the section.]

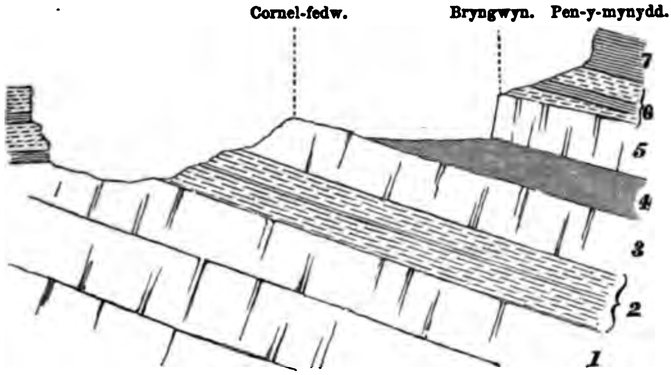
Thin seam of Coal.—Base of the Coal Measures.	Thickness. ft.	in.
Compact Sandstone, with crystals of felspar, varying in texture from a coarse conglomerate to fine grained sandstones used for building purposes	78	0
Dark grey clayey shale	0	9
Grey flinty stone	4	0
White shale	1	3
Dark grey shale, with iron pyrites	9	3
Hard white sandstone	16	0
White clay and chert	6	0
Black shale	0	3
Hard cherty rock; decomposes into rotten stone	5	0
Black shale	2	0
Hard rock	2	4
Black shale	0	3
Hard rock	2	0
Fire-clay	2	0
Ditto and sand	1	8
Rock	0	10
White Rock	0	2
Brown ditto	0	10
Dark shaly rock	0	10
Black shale	0	3
White rock	0	4
Shale	3	0
Limestone (metalliferous). [N.B.—Broke my chisel]	1	3
	138	3

Section taken along the outcrop of the beds to the junction of the Grit with the Limestone. The figures must be regarded as approximately correct.

White cherty limestone, in thin splintery beds, below a solid bed of limestone, 1ft. 6in. thick, corresponding with the base of section above	16	0
Massive white sandstones with pebbles, forms two ridges	40	0
,, ,, ,, ,, forming a lower ridge	27	0
Brown sandstones, a little calcareous, passing downward into a lighter colour of	8	0
Yellow and brown sandstones	4	0
Pink and white variegated sandstones	20	0
Calcareous sandstones	35	0
Yellowish white, with darker coloured ditto, with purple calcareous spots	3	0
Thin flaggy buff and yellow sandstone beds, in places honeycombed by decomposition of mineral matter, as at Cragford and Bronygarth... resting on	3	0
	294	3

Pale limestone, few fossils, near the junction, but passing downwards into an encrinital and coralline limestone. Top of the main body of Carboniferous Limestone of the Eglwseg Rocks.

Fig. 8.—Section of Millstone Grit, with interstratified limestones, 3½ miles west of Mold, Flintshire.



	ft.	in.
1. **Main body of Carboniferous Limestone.**		
2. **Massive reddish white, dark red, and yellowish sandstones**	55	0
3. **Massive arenaceous limestone**	40	0
4. **Clays, limestones, and yellowish sandy beds**	52	0
7. **Massive limestones**	49	0
5. **Various purplish calcareous sandstones, with encrinites and coralline limestones** ...	35	0
6. **Massive crystalline white sandstones, with occasional layers of pebbles, and fucoid markings between the beds**	63	0
	294	0

(Measurements to be taken as approximately correct.)

Passing on to Trevor, three miles east of Llangollen, we have the upper beds made up (as shown in the accompanying Trevor section) of compact sandstone, with crystals of felspar, ranging in texture from a coarse friable conglomerate to a fine-grained sandstone. This character it maintains (omitting the friable conglomerate) to Mold, in Flintshire, where it forms the topmost sandstone of the Mold section (see Woodcut, Fig. 8). The basement beds at the two extremities of the formation differ considerably: at the southern end they are red and purplish sandstones; at the northern termination, on the Ormes Head, we find the main body of the limestone immediately succeeded by a succession of cherty beds. The middle beds preserve their calcareous character throughout the entire area, becoming more decidedly calcareous in their passage northwards; for example, taking three points at about equal distances, we have—

(South.)	At Sweeney (1 mile).	Trevor (15 miles).	Mold (30 miles).	(North.)
	Calcareous sandstones, with occasional thin layers of limestone.	1ft. 6in. limestone, 16ft. cherty ditto, calcareous sandstones.	About 120ft. limestone.	
Total thickness of each section.	282ft.	294ft.	294½ft.	

So rapid is the increase of calcareous matter, in the last fifteen miles, that it is difficult, when looking at the Mold section, to say whether we have, as shown on the Government Survey maps, Millstone Grit with bands of limestone, or, limestone interstratified with beds of grit.

(To be concluded in our next Number.)

VII.—Notes on the Cretaceous Entomostraca.

By Prof. T. Rupert Jones, F.G.S., of the Royal Military College, Sandhurst.

I HAVE lately been urged to revise the Cretaceous species of Entomostraca, enumerated in my Monograph, published by the Palæontographical Society in 1849. This I ought to have done ten years ago, after the publication of memoirs on the Cretaceous Entomostraca of Germany, the Netherlands, etc., by Reuss, Bosquet, and others, wherein some of my determinations of species are corrected from actual comparison of specimens. An improved classification was attempted in my Monogr. Tert. Entom., 1856; but a total revision is still more necessary now, because the late researches by Sars and G. S. Brady, in the structure and character of the recent Entomostraca, have multiplied and elucidated species and genera of these little bivalved crustacea to an amazing extent. So clearly has Mr. Brady's "Monograph of the recent British Ostracoda" (Linnean Soc. Trans., 1868), in particular, defined the several groups, that we may in very many cases form a safe opinion of alliances from the shape, hinge, and other characters of the carapace-valve, at least far more satisfactorily than when in 1849 (Monogr. Cret. Entom.), and in 1856 (Monogr. Tert. Entom.), I laboured to institute some definite distinctions for fossil Entomostraca, founded on these characters.

The interchange of specimens above alluded to has cleared away some obscurities; but others remain, and I hope to go over all my old work some day, with the new lights, and to reproduce the necessary figures for illustration of our Cretaceous species, on a smaller scale, and with much clearer and more accurate drawing than we find in my Monograph of 1849. For the present, I offer the subjoined remarks on the published British species.

1. *Cythere Hilseana* (Rœmer). Monogr., p. 10. M. Bosquet, having compared some specimens, found that this is not Rœmer's *C. Hilseana*, and named it *C. Jonesiana* in his Descript. Ent. foss. tert. p. 38 (1852), and in his Crust. foss. Limbourg, p. 74 (1854). In my Monogr. Tert. Entom., p. 45, however, I show that Rœmer's *C. perforata*, Bosquet's *Bairdia perforata*, and the species in question (which is a *Cytheridea*), are the same. It stands therefore as *Cytheridea perforata*, Rœmer, sp.

2. *Cythere punctatula* (Rœmer). Monogr., p. 11. M. Bosquet has shown that this is not Rœmer's *C. punctatula*, which, he says, is probably the young of *C. Hilseana* (Crust. foss. Limbourg, p. 72). Reuss first named it, and it is to be registered therefore as *Cythere concentrica*, Rss.

3. *Cythere umbonata* (Williamson). Monogr., p. 12. This appears to me to be probably a *Cytheropteron*, as defined and figured by G. S. Brady in his "Monogr. recent British Entom." and other memoirs.

4 and 5. *Cythere faba* (Rss.), and *Cythere Bairdiana* (Jones) Monogr., p. 13. These appear to be rightly placed as to genus though neither is well defined; the former, however, is not Reuss'

C. faba (see Reuss's remarks on this point in the "Zeitsch. d. g. Ges.," 1855, vol. vii., p. 278), and therefore must have another name. I register it as *C. simulata.*

6. *Cythereis interrupta* (Bosquet). Monogr., p. 16. According to my friend M. Bosquet, this is decidedly different from his species. It requires therefore another name. As *Cythereis* is now merged by G. S. Brady in *Cythere*, on anatomical grounds (Mon. rec. Brit. Entom., p. 401), I term this well marked species *Cythere Harrisiana*, after Mr. Harris, F.G.S., of Charing, to whose researches we were indebted for the specimens.

7. *Cythereis Gaultina* (Jones), Monogr., p. 17, is a *Cythere.*

8. *Cythereis macrophthalma* (Bosquet). Monogr., p. 17. This also is a *Cythere* for the reason above given. M. Bosquet doubts if it be the same as his species; but I see no reason to hesitate in the determination, looking at the English and foreign specimens.

9. *Cythereis triplicata* (Rœmer). Monogr., p. 18. A well marked *Cythere.*

10. *Cythereis quadrilatera* (Rœmer). Monogr., p. 18. Another *Cythere.* M. Bosquet doubts its being distinct from the next mentioned; but I prefer to keep them separate, as their young forms differ.

11. *Cythereis ciliata* (Reuss). Monogr. p. 19. Dr. Reuss having shown his specimens to M. Bosquet, the latter has decided that *C. ornatissima* (Rss) and *C. ciliata* (Rss), are the same; and, as "*ornatissima*" precedes the other name, it must be adopted.

12. *Cythereis Lonsdaleiana* (Jones). Monogr., p. 20. A good *Cythere.*

13. *Cythereis cornuta* (Rœmer). Monogr., p. 21. M. Bosquet has taken much trouble with this form. He thinks it cannot be Rœmer's "*cornuta,*" and probably with reason. It may be registered as a variety of *Cythere ornatissima.*

14. *Cythereis alata* (Bosquet). Monogr., p. 21. This *Cythere* retains its name.

15. *Bairdia subdeltoidea* (Münster), Monogr., p. 23. Name unaltered. In this, as in other cases, the Tertiary and Recent forms referred to in the Monograph as being of the same species require complete revision. Mr. G. S. Brady has described some of them as distinct; and the Rev. A. M. Norman has determined the "narrow variety" from Arran to be also distinct (*B. inflata*).

16. *Bairdia siliqua*, and two varieties (Jones). The large form, or *B. siliqua* proper, is a *Macrocypris*, near to *M. Minna*, Baird, sp.

Var. *a* is also probably a *Macrocypris*, and I am inclined to place it with Münster's "*Cythere arcuata,*" as *M.*(?)*arcuata*, Münster, sp.

Var. *β* is a different form altogether, possibly a *Paracypris*, resembling "*C. arcuata*, var. *gracilis,*" Bosquet. It may be registered as *Paracypris*(?) *gracilis.*

17. *Bairdia Harrisiana* (Jones). Monogr., p. 25. Stands good. M. Bosquet thought he recognized this form in his *Cytheridea Harrisiana* (Crust. foss. Limbourg, p. 63, pl. 5, fig. 5), but Mr. Brady shows he is wrong (Trans. Zool. Soc. 1866, p. 363).

18. *Bairdia angusta* (Münster). Monogr., p. 26. This is a *Cytherideis*; and though the specific determination is doubtful, being based on Count Münster's vague description, yet I do not propose to interfere with it.

19 and 20. *Bairdia triquetra* (Jones), and *Bairdia silicula* (Jones). Monogr., p. 27. These are not well defined, but most probably belong to the genus *Bairdia*.

21. *Cytherella ovata* (Rœmer). Monogr., p. 28. A well-known species.

22. *Cytherella truncata* (Bosquet). Monogr., p. 30. M. Bosquet is satisfied that this is the same as *Cytherella Muensteri*, Rœmer, sp. (1838). See also my Mon. Tert. Entom., p. 56; here, however, possibly, pl. 5, fig. 12, belongs to another species.

23. *Cytherella Williamsoniana* (Jones). Monogr., p. 31. A good species, for which many allies have been found in the Cretaceous formations of Europe, and in the recent state. Possibly var. *granulosa* is a distinct species.

24. *Cytherella*(?) *appendiculata* (Jones). Monogr. p. 32. This is far more likely a *Cytherura*.

25. *Cytherella*(?) *Mantelliana* (Jones). Monogr., p. 32. This may be accepted as a true *Cytherella*.

26. *Cytherella*(?) *Bosquetiana* (Jones). Monogr, p. 33. Not a *Cytherella*; but probably a *Cythere*.

Over-cautious in referring our English forms to published (and often badly figured) Continental species, and too bold in assigning wide limits to specific and generic groups, in my Monograph on the Cretaceous Entomostraca, I stretched a palæontological virtue into an error, which better knowledge, attained by the work of many, will enable us to rectify in detail.

I must add that the references frequently made in the Monograph to similar Entomostraca in other geological formations, and in existing seas, have to be re-examined in very many cases, and much curtailed. I again express my hope of being able to publish far better drawings of these Cretaceous species.

Appended is a corrected list of the Cretaceous species :—

OLD NAMES.	NAMES NOW ADOPTED.
Cythere Hilseana, Rœmer.	*Cytheridea perforata*, Rœmer, sp.
„ *punctatula*, Rœmer.	*Cythere concentrica*, Reuss.
„ *umbonata*, Williamson.	*Cytheropteron umbonatum*, Will., sp.
„ *faba*, Reuss.	*Cythere simulata*, Jones (1869).
„ *Bairdiana*, Jones.	*Cythere Bairdiana*, Jones.
Cythereis interrupta, Bosquet, sp.	*Cythere Harrisiana* Jones (1869).
„ *Gaultina*, Jones.	„ *Gaultina*, Jones.
„ *macrophthalma*, Bosquet, sp.	„ *macrophthalma*, Bosquet.
„ *triplicata*, Rœmer, sp.	„ *triplicata*, Rœmer.
„ *quadrilatera*, Rœmer, sp.	„ *quadrilatera*, Rœmer.
„ *ciliata*, Reuss, sp.	„ *ornatissima*, Rss.
„ *Lonsdaleiana*, Jones.	„ *Lonsdaleiana*, Jones.
„ *cornuta*, Rœmer, sp.	„ *ornatissima*, var.
„ *alata*, Bosquet, sp.	„ *alata*, Bosquet.

OLD NAMES.	NAMES NOW ADOPTED.
Bairdia subdeltoidea, Münster, sp.	*Bairdia subdeltoidea*, Münster, sp.
„ *siliqua*, Jones.	*Macrocypris siliqua*, Jones.
„ *Var. α.*	*Macrocypris ? arcuata*, Münster, sp. ?
„ *Var. β.*	*Paracypris ? gracilis*, Jones (1869).
„ *Harrisiana*, Jones.	*Bairdia Harrisiana*, Jones.
„ *angusta*, Münster, sp.	*Cytherideis angusta*, Münster, sp.
„ *triquetra*, Jones.	*Bairdia triquetra*, Jones.
„ *silicula*, Jones.	*Bairdia silicula*, Jones.
Cytherella ovata, Rœmer, sp.	*Cytherella ovata*, Rœmer, sp.
„ *truncata*, Bosquet.	„ *Muensteri*, Rœmer, sp.
„ *Williamsoniana*, Jones.	„ *Williamsoniana*, Jones.
„ ? *appendiculata*, Jones.	*Cytherura appendiculata*, Jones.
„ ? *Mantelliana*, Jones.	*Cytherella Mantelliana*, Jones.
„ ? *Bosquetiana*, Jones.	*Cythere Bosquetiana*, Jones.

VIII.—ON *DEXOLITES GRACILIS*, A NEW SILURIAN ANNELIDE.

By JOHN HOPKINSON, F.G.S., F.R.M.S.

(With a Woodcut.)

OF the existence of Annelides during the Silurian period we are almost as uncertain as of the existence of plants. Indeed, we might reasonably doubt whether any Silurian fossils can with certainty be referred to this class.

The tracks and filled-up burrows, formerly regarded as plants, are as likely to be produced by crustaceans or molluscs as by worms :[1] mere impressions or casts are almost equally uncertain in their nature, and the shelly tubes, such as *Tentaculites* and *Cornulites*, are also of doubtful origin.[2]

We have a remarkable instance of this uncertainty in the genera *Scolites* and *Arenicolites*, which one of our most distinguished palæontologists has lately referred to as affording "more tangible evidence of the Annelida" than such markings as *Nereites Cambrensis*,[3] but which, from the discovery of specimens showing internal structure, are now known to be sponges.[4]

It is therefore, with some doubt, that I describe as a new Silurian Annelide, that, which, to say the least, appears to me as like a worm as any Silurian fossil yet known.

I assume my specimens to be impressions of the body of a worm, and describe them provisionally as such, though it is possible they may be only tracks.

Dexolites, gen. nov. (δήξ—a worm ; λίθος—stone). Body slender, cylindrical, flexible, tapering towards each end, and distinctly and regularly annulated (See Woodcut).

Dexolites gracilis, sp. nov.—Body from about half an inch to one inch long, about one-twentieth broad, slightly tapering towards each end, and with about thirty (or more) well marked body rings, which are apparently equal in width to the space between them, and, in the same specimen, at equal distances apart.

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[1] See "Siluria," 1867, p. 201 and p. 513.—EDIT.

[2] Owen, Palæontology, 1860, p. 40.

[3] W. H. Baily, Charac. Brit. Foss., part I., p. xix.

[4] Nature, Dec. 30, 1869, p. 248.

Fig. 1.

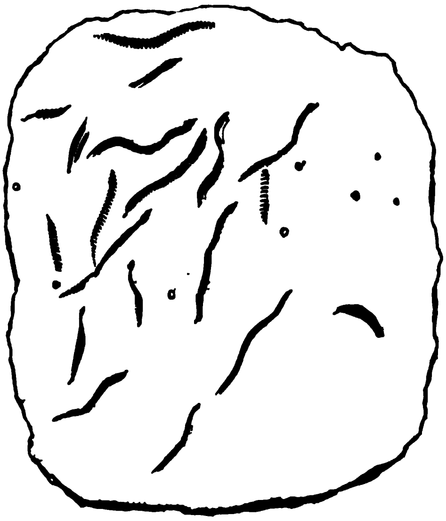


Fig. 1a.

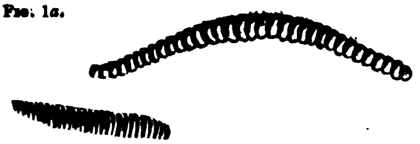


Fig. 1. Slab of Shale covered with *Dexolites gracilis*, sp. nov., Upper Llandeilo, Moffat, Dumfriesshire.
,, 1a. The same, much enlarged.

Few specimens show these characters clearly, some not even appearing annulated, while in others a few rings only can be made out. At the side of one well-marked impression, and towards one (? the anterior) end of the body, are a few indistinct marks of body rings, which I can only account for by supposing that the animal has here moved laterally. Its mode of progression appears to have been the same as in our common earthworms,—by the muscular extension and contraction of the body; for in the few specimens I have found, the body appears to be longer in proportion as the rings are farther apart. For instance, in each of three distinct impressions, which measure respectively three-eighths, five-eighths, and three-quarters of an inch, from twenty-eight to thirty body rings can be counted, being in the proportion of about fifty to the inch in the longest individual, and fully ninety in the shortest.

It appears in relief in graceful curves on the surface of the strata, when the body rings are well shown; as a depression, when they can scarcely be seen; in section, perpendicular to the plane of deposition, or cutting obliquely through it.

Locality:—Hunterheck Hill, Moffat, Dumfriesshire. In light-coloured indurated micaceous shales of Upper Llandeilo age.

In this locality the only other fossils sufficiently distinct for determination are the supposed Annelides, *Crossopodia Scotica*, *Nereites Cambrensis*, and *Trichoides ambiguus*. The two former occur in a more arenaceous deposit; the latter, in association with *Dexolites gracilis*. This scantily fossiliferous zone is quite distinct from the highly fossiliferous zone which is so well known for its rich Graptolite fauna. Its dip (that of the Annelide zone) is about 75° N.N.W., the normal dip of the unfossiliferous greywacké in which it occurs. It appears to be lower than the graptolite beds, but, owing to the contortions of the strata in which these two zones occur, their precise relations are not clearly understood.

I append a list of the fossils of Dumfriesshire, in which a few species, not previously recorded, are included. It will be seen that there are a greater number of Llandeilo species than of Caradoc. many being common to the two formations elsewhere; and that there are very few Arenig (or Lower Llandeilo) forms. Many species have not, as yet, been found elsewhere.

Graptolitidæ Hydrozoa.
Corynoides calicularis, Nich.
Retiolites perlatus, Nich.
Graptolitidæ.
Rastrites capillaris, Carr.
,, *Linnæi*, Barr.
,, *maximus*, Carr.
,, *peregrinus*, Barr.
Graptolithus convolutus, His. sp.
,, *Clingani*, Carr.
,, *Halli*, Barr.
,, *Hisingeri*, Carr.
(=*G. sagittarius*, His. sp. non Linn.)
,, *intermedius*, Carr.
,, *lobiferus*, M'Coy.
(=*G. Becki*, Barr.)
,, *Nilssoni*, Barr.
,, *Sedgwickii*, Portl.
Didymograpsus elegans, Carr.
,, *Forchhammeri*, Gein. sp.
,, *Moffatensis*, Carr.
(=*D. anceps*, Nich.)
Cladograpsus capillaris, Carr.
,, *linearis*, Carr.
Helicograpsus gracilis, Hall, sp.
Diplograpsus angustifolius, Hall, sp.
,, *bimucronatus*, Nich.
,, *dentatus*, Brong. sp.
,, (=*D. pristiniformis*, Hall.)
,, *folium*, His. sp.
,, *minutus*, Carr.
,, *mucronatus*, Hall, sp.
,, *insectiformis*, Nich.
Diplograpsus palmeus, Barr.
,, *penna*, Hopk.
,, *pristis*, His. sp.
,, *pusillus*, Hall, sp.
,, *tamariscus*, Nich.
,, *tricornis*, Carr.
,, *vesiculosus*, Nich.
,, *Whitfieldi*, Hall, sp.
Cephalograpsus cometa, Gein. sp.
Climacograptus bicornis, Hall.
,, *minutus*, Carr.
(=*C. innotatus*, Nich.)
,, *scalaris*, Linn.
(=*C. teretiusculus*, His. sp.
,, *tuberculatus*, Nich.
Dicranograptus Clingani, Carr.
,, *ramosus*, Hall.

Actinozoa?

Protovirgularia dichotoma, M'Coy.

Brachiopoda.

Lingula attenuata, Sby.
,, *brevis*, Portl.
Siphonotreta micula, M'Coy.

Annelida.

Crossopodia Scotica, M'Coy.
Dexolites gracilis, Hopk.
Nereites Cambrensis, M'Coy.
Tentaculites, sp.
Trichoides ambiguus, Harkn.

Crustacea.

Discinocaris Browniana, Woodw.
Peltocaris aptychoides, Salt.
,, *Harknessi*, Salt.

NOTICES OF MEMOIRS.

◆

I.—Notes on the Ophiuridæ.

By Dr. C. F. Lütken, of the Zoological Museum in the University of Copenhagen.

[*Additamenta ad historiam Ophiuridarum.* Part 3. 1869. From the Transactions of the Royal Danish Academy of Science. Communicated by the Author.]

In this paper I have given a general synopsis of all hitherto established genera of recent *Ophiuridæ*, with their chief characters in Latin, and a critical essay on the genera of fossil *Ophiuridæ*. This section of Palæontology is yet in a very unsatisfactory condition, owing partly to the unscientific manner in which D'Orbigny characterised his genera. Thus the genus *Ophiurella*, Ag., is established on *O. speciosa*, Münst. (from the Lithographic Limestone), and is characterized chiefly by "un disque à peine distinct;" but this fossil is evidently a true species of *Ophiocoma*, having lost its disc, a very common accident with *Ophiuridæ*, especially when the disc is more or less soft. D'Orbigny's *Ophiurella bispinosa* is only known from a short diagnosis, and should be more fully described. *Ophiura Griesbachii.* Wright (with a very distinct disc), has nothing in common with the typical species of the genus: its true position I cannot decide, it has the general aspect of an *Ophioglypha*, Lyman, (*Ophiura*, Forbes). The genus *Ophiurella* must of course be eliminated from the catalogue. The genus *Acrura* is based upon the *A. prisca*. Münst., of the Trias, a species that appears to be closely related to *Amphiura*, Forbes; and if it be retained as the type of a peculiar genus. it cannot be clearly defined. The best preserved fossil, *Ophiuridæ*, almost always want those organs of the superficial tegumentary system,— teeth, papillæ of the mouth and arms, spines, spinules, granulations, etc.,—which are so important for the determination of the recent species; they can therefore be referred but exceptionally to their true genera. Nor, if they belong to extinct types, can they be properly characterized, owing to their imperfect preservation. In some instances also the true arm-plates are more or less completely lost, and then all that can be said, is, that the fossil is a typical Ophiuroid, but of its affinities hardly a guess can be made; cases will be cited further on. *Acrura Cottaldina* and *A. subnuda*, D'Orb., are only known from insufficient diagnoses, and are therefore at present indeterminable. *A. Cornuelana*, and *A. serrata*, Roem., are probably best placed in the recent genus *Ophioglypha*, Lym.

Acrura Brodiei, Wr. is one of those very imperfectly known forms that might well be placed provisionally in the old genus *Ophiura*. Possibly *Aspidura loricata*, Goldf. is really the type of a peculiar genus, but I do not know how to characterize it satisfactorily. The characters given to all these genera by D'Orbigny are really valueless, and are based on no knowledge whatever of the characters of the recent Brittle-Stars. Count Münster's figure of the same form is also incorrect; the star of small scales, filling up the aperture of the mouth, does not exist in nature; the animal had the typical mouth of an ordinary Ophiuroid. If Hagenow's figure of *Aspidura Ludeni* (copied by D'Orbigny and Vogt as that of *Palæocoma Furstenbergii!*) be compared with the preceding species, a certain general resemblance of aspect will be found, but no evidence of generic identity. Picard's *Aspidura squamosa*, and *A. coronæformis* would have been better placed with *Amphiura* or with *Acrura*. *Aplocoma* (*Haplocoma?*) *Agassizii* is quite indeterminable. I do not deny that *Geocoma carinata* and *libanotica* have some characters apparently in common: they somewhat recall badly preserved specimens of *Ophiothrix*, but I do not see any likeness between them and *Geocoma elegans* of Heller.

Three species have been referred to *Palæocoma*:—(1) *P. Cunliffei*, Forb., based upon some indeterminable fragments; (2) *P. Furstenbergii*, tolerably well known, nevertheless I dare not decide on its true affinities; (3) the typical species, *P. Milleri*, Phill. (= *P. loricata*, Williamson), referred by such distinguished palæontologists as Forbes and Wright to *Ophioderma*. I have vainly sought for the cause of this arrangement, which is directly contradicted by the great radial plates, never to be found in *Ophioderma*. The same must be said of the other Liassic and Oolitic *Ophiodermæ* (*O. Egertoni*, *O. tenuibranchiata*, *O. Gaveyi*, *O. carinata*, and *O. Escheri*). I see no reason at all why they should not be referred to *Ophioglypha*; they must at least belong to a very closely allied genus; perhaps I should except *O. Egertoni*, specimens of which, in the museum at Copenhagen, have the general aspect of *Ophioderma*. *Ophi(y)coma granulosa*, Roemer, is quite indeterminable, but has nothing to do with *Ophiocoma*.

Of D'Orbigny's genera, some are identical with living genera (*Palæocoma* = *Ophioglypha*, *Ophiurella* = *Ophiocoma*), some must be rejected because their characters are based on the absence of some part of the external skeleton, owing to the imperfect state of preservation (as *Hylocoma*, *Ophiocoma*), while others may be retained (*Acrura*, *Aspidura*), but without definite limits or satisfactorily established characters.

So much for the genera of D'Orbigny! I shall briefly notice the other species of fossil Ophiuridæ, that I have found described or enumerated by the authors. *Ophiura Murravii* and *Wetherelli*, Forb. are justly referred to *Ophioglypha;* and perhaps also *Ophiolepis Ramsayi*, Wright, when it is more fully known. *Ophiura granulosa* and *subcylindrica* of Hagenow, and *O. olifex* of Quenstedt are quite indeterminable. *O. Bonnardi*, Oppel, is, I believe, undescribed.

Amphiura Pratti, Forbes, I formerly regarded as correctly determined, judging from the original figure and description; but after having seen those of later date by Dr. Wright, I do not know what to make of it. I cannot identify *Ophiolepis gracilis*, Allmann, with any recent species: if completely known in all its details, it would perhaps be the type of a peculiar genus. It is closely allied to *Amphiura*, but the long arm-spines are an aberrant character: they are, however, described as "rather short" by Mr. Walker. *Ophiura Gumäelii*, Lindström, from the Jurassic strata of Spitzbergen, is referred by its describer to *Ophioglypha*, and especially compared with O. *affinis*, but it has some remarkable characters of its own, *e.g.* the deep fissures in the back of the disc between the radial scutes, and the peculiar club-like form of the arms.

From the formations older than the Trias, we only know some Silurian species, described under the names of *Protaster*, *Tæniaster*, *Eugaster*, and *Ptilonaster*. With the exception of a single very fine specimen of *Protaster Miltoni*, I can only judge of these genera from the descriptions and figures, but I am convinced that they are all true typical *Ophiuridæ*, having no affinities with the *Euryalidæ*, nor with the *Asteridæ*, as has been supposed. I do not believe that *Eugaster* and *Tæniaster* are separable from *Protaster*; the characters given are either of a slight value, generally, for the distinction of genera, or their real existence in nature appears rather doubtful.

With *Ptilonaster* the case is different, as this genus is stated to have a quadruple series of ventral (ambulacral) arm-plates in place of the double series in *Protaster*, etc. But after an examination of specimens of *P. Miltoni*, I have some suspicion that the superficial (dorsal and ventral) arm-plates, and the internal true ambulacral ossicles have sometimes been confounded together. In the *P. Miltoni* before me I can detect the scaled disc, the stellate mouth, the ophiura-like arms, the lateral arm-plates with the spines, and the internal ossicles (which are certainly neither bifid nor alternate, as stated in other species), and I believe that these true internal ambulacral ossicles have sometimes been described in *Protaster*, *Tæniaster*, etc., as double dorsal or ventral arm-plates. The characters of *P. Miltoni* are those of a true ophiuroid, and though the other species may be in some respects enigmatical, I have no doubt that they are, after all, true Ophiuroids. The "madreporite" is stated to lie on the back of the disc in *Protaster*, a position that certainly would be very aberrant. I can see nothing of this kind on the specimen before me, and do not think the statement to be confirmed by the figures published. In regard to Salter's *Palæocoma* (not to be confounded with D'Orbigny's genus), and the very analogous Devonian genus, *Aspidocoma*, Goldf., I am incapable of deciding whether they are *Ophiuridæ* or *Asteriadæ*, though I have studied specimens of the latter genus.

I venture to publish these remarks in the hope that a critical review of the fossil *Ophiuridæ*, from the pen of a Zoologist, who for several years has made the recent ones the subject of his studies, may be of some use, though the materials at my disposal are not rich. In order that this part of Palæontology may advance, more attention must be paid to the recent forms than has hitherto been the case. I will only add, that in an additional chapter I have discussed the intricate question whether *Harlania Halli* (*Arthrophycus*, Göppert), from the Silurian beds of North America, is really a Fucoid, as supposed by most authors (compare the *Rhysophycus embolus* of Eichwald), and I have stated that I did not know any natural objects with which this fossil has a greater external likeness than the lower arm-branches of *Asterophyton*—leaving it to be decided, by those having plenty of specimens at hand, if this presumed cryptogamous plant should possibly turn out to belong to the animal kingdom, and to the tribe *Euryalæ*. C. F. L.

REVIEWS.

I.—The Geology of St. Helena. By Capt. J. R. Oliver, R.A., 8vo., pp. 32, Jamestown, St. Helena, 1869. With a lithographed Plate of Sections, printed at the Royal Artillery Institution, Woolwich.

We have in this pamphlet the results of a geological examination of St. Helena, by a Staff Officer lately residing there, who *had not seen* Mr. Darwin's work on "Volcanic Islands," chapter iv. of which gives a masterly, though avowedly imperfect, account of its interesting, but obscure and complicated, structure. Many points of agreement must of course occur in two careful descriptions of a limited area; but as Capt. Oliver's stay lately on the island was longer than the Surveying Voyage of the "Beagle" allowed to Mr. Darwin thirty years ago, we may look for, and do find, various points on which some information is added by the artillery officer, who applied his geological knowledge to elucidate some of the structural difficulties of St. Helena, and to enhance the pleasures of his many excursions over and around the island.

St. Helena is geologically and geographically divisible into three unequal portions, namely, 1st. The south-western district, or "Sandy Bay basin," defined by the remains of the encircling boundary cliffs of an enormous crater, breached at Sandy Bay, and comprising irregular augitic lavas, traversed by great (north-east–south-west) dykes; 2ndly. The north-western or "Jamestown district" (from Flagstaff Bay to Manati Bay), consisting of uniformly stratified basaltic lavas and clay beds, dipping north-west, and traversed with dykes; 3rdly. The eastern third of the island, or the "Longwood district," composed of more recent volcanic materials, namely, hard lavas, different from those of the other side of the island, dipping at a low angle to the north-east, and intercalated with whitish clay-stone, with veins of manganese, etc. These nearly horizontal lavas lie on older, hard, lava beds, upturned, confused, and traversed with many dykes. This latter series seems to comprise disturbed portions of the Jamestown series, and constitutes, with it, the "much broken ring, or rather horse-shoe of basalt," described by Darwin. Some of it, older than the rest, constitutes Darwin's "Basal series" (between the Flagstaff Hill and the Barn, for instance, at the north-east portion of the island).

The chief points on which Capt. Oliver gives us new information are as follow:—1. Mr. Darwin was not aware that the base only of the remarkable peak called "Great Stone Top" belongs to the "Basaltic Ring series;" the upper part, of almost 1000 feet vertical height, being a nearly homogeneous cone of grey felspathic rock (phonolite), similar to "Little Stone Top." The latter cone is based on a white claystone, and the two must have originally belonged to one continuous mass. 2. It is only the summit of "Flagstaff Hill" that is formed of felspathic lava; the rest is basaltic. The "Basaltic Ring" extends unbroken from "Flagstaff Hill" to "Man-and-Horse," forming the north-west coast. It slopes rapidly upwards towards the central ridge, and is everywhere (high up) overlain conformably by newer felspathic beds. The dip of its strata is much the same throughout, and the great dykes in the floor of the crater (Sandy Bay basin) run nearly parallel to their strike. The heights of its summits are very uniform, and, except at "Flagstaff," it contains few dykes. The author thinks that the "Flagstaff" has been upheaved by local disturbances, but not so greatly as Mr. Darwin suggests. 3. He strongly doubts the propriety of referring the "Barn" to the "Basaltic Ring." In their aspects and characters the rocks of the two are different. Whether the place of an old outburst, or not, the "Barn" consists of enormously tilted lavas, and requires further examination. 4. Capt. Oliver thinks that the coloured clay beds, in the Longwood District, are due to the surface decomposition of thick, hard claystones, and not of scoriæ. 5. He points to the existence of a great submarine terrace around the island, sloping outwards to a depth of 50, 70, 100 fathoms and more, and averaging nearly two miles in width, with an abrupt descent into very deep water. The prolongation of the plane of the existing land approximately touches the outer margin of this terrace, quickly if the land surface slopes rapidly, and at a lower angle if the land slopes gently (according to the dip of the strata generally); in fact, according to the greater or less inclination of one slope, so is that of the other; the submarine terrace, however, is less inclined than the slope of the land. Hereby some of the physical changes of this old island are clearly illustrated. Doubtless the land reached a much greater elevation—some thousands of feet—with a wider base at some far distant period, when the accumulation of the volcanic matter, and the uplifting of the mass, formed a lofty conical island, with sloping coasts. Into these in time the sea ate an enormous terrace-like notch, or littoral groove; and after a subsidence, it began to eat away the present coast, and to grind down and disperse as mud "the enormous cubic mass of hard rock which has been pared off the circumference of the island," a denudation so great, says Darwin, that "the mind recoils from an attempt to grasp the number of centuries of exposure" necessary for its production; and yet this coast-notch is neither the first nor the greatest that has margined St. Helena.

Whether or no these were the only great changes of level, some sloping shore must have existed, in place of the precipices of to-day, for the upblowing of the calcareous shore-sand, on to the sides of valleys and flanks of hills six hundred feet above the sea, and forming the superficial limestone, well described and accounted for by Darwin. Many movements of oscillation, besides those of local disturbance, may have occurred; and the enormous denudation the surface of the island has suffered may be due in part to sea-action; but in a far great degree it is attributable to rainfall and snow-water, due to the exceeding loftiness, or to some old "pluvial period." The amount of moisture at present is sufficient to give luxuriant vegetation to the central heights, and brooks in abundance; but it effects a very trifling amount of superficial change.

To resume:—On many other points besides the origin of the superficial calcareous deposits, and the enormous denudation, our authors fully agree—1. The volcanic origin of the whole mass of the Island. 2. The existence of the "basal series," from the Barn to Prosperous Bay, much intersected by dykes, upturned, and overlain by newer beds of lava. 3. The distinct character of the Flagstaff Hill and Barn. 4. The extent and characters of the "Basaltic series," doubtfully of submarine origin. 5. The great crater, at Sandy Bay, as the origin of most, if not all, of the eruptions. The felspathic deposits of Sandy Bay Ridge, and the almost horizontal beds of the Longwood district being the latest lavas, succeeding to disturbances of the earlier formations. 6. The nature of the parallel dykes at Sandy Bay. The floor, however, of this great crater, and its remarkable rim are more minutely described by Darwin.

Surely, if such be the results of a careful comparison of the unpretending brochure before us with the high-class production of such a learned geologist as Darwin, we ought to congratulate the veteran, in that the integrity of his work is so well supported by the independent researches of another; and we ought to congratulate Capt. Oliver on having observed and philosophized so well as to find his work fully in accord with that of his great, but to him unknown predecessor. Lastly, we have to welcome among us a geologist who can add to our knowledge of the geological history of St. Helena one of the oldest and least known of volcanic cones; and that, with the greater pleasure, as a military officer, one of many, who have helped, and will help to increase the bounds and influence of Natural Science by the exercise of their own intellectual powers, and by the diffusion of useful knowledge. T. R. J.

REPORTS AND PROCEEDINGS.

Geological Society of London.—December 22nd, 1869.—Prof. Huxley, LL.D., F.R.S., in the chair. The following communications were read:—1. "On the Iron-ores associated with the Basalts of the North-east of Ireland." By Ralph Tate, Esq., Assoc. Linn. Soc., F.G.S., and John S. Holden, M.D., F.G.S.

The authors introduced their account of the iron-ores of the Antrim basalts, by stating that since 1790 an iron band had been known in the midst of the basalt of the Giant's Causeway, but that only within the last few years have further discoveries been made, which have developed a new branch of industry in the north-east of Ireland.

The iron-ore of the numerous exposures was considered to represent portions of one sheet, extending uniformly throughout the basalt, and over a very large area. Indeed everywhere the iron band and its associated rock-masses present identical features, from which the authors deduced the following generalized section:—

The underlying basalt gradually passes upwards into a variegated lithomarge of about 30 feet thick, graduating insensibly into a red or yellow ochre or bole of about 5 to 6 feet in thickness, which passes into a dense red ochreous mass of about 2 feet, charged with ferruginous spheroids consisting chiefly of a protoxide and peroxide. The spheroids are of the average size of peas; they increase in number and size towards the upper part of the band, and not unfrequently constitute that portion of it. The line of junction between the iron band and the overlying, and usually more or less columnar basalt, is in all cases well defined, and in a few instances exhibits decided unconformability.

The authors discussed the several theories that may be suggested to account for the origin of the present condition of the pisolitic ore, and proceeded to point out what appear to have been the several stages of metamorphic action by which the pisolitic ore had been elaborated out of basalt. From field observations and chemical analyses they have been led to consider the bole and lithomarge as the resultants of aqueous action in combination with acidulated gases, which, dissolving out certain mineral substances, have effected the decomposition of the basalt; and to assume that the bole underlying the iron band was a wet terrestrial surface, and that the subsequent outflow of basalt effected (by its heat, pressure, and evolved gases) a reduction of the contained oxides of iron into the more concentrated form in which they occur in the pisolite, the aggregation of the ferruginous particles being a result of the same actions.

The ferruginous series, with interstratified plant-beds at Ballypalidy, was next described, and demonstrated to be of sedimentary origin; the ferruginous conglomerate resulting from the degradation of the pisolitic ore, of which it is chiefly reconstructed, and of the underlying ochres.

Many additions were made to the list of plant-remains from these beds; and priority of discovery of plants in the Antrim basalts was accorded to Dr. Bryce, F.G.S.

DISCUSSION.—Mr. D. Forbes was not prepared to admit some of the theoretical conclusions of the authors, and objected to calling in metamorphism to account for all that was hard to be understood. He could not recognize the division of beds so similar in character into two classes. He wished to know, assuming that the iron-ore merely resulted from the decomposition of the basalt, what became of all the silica and alumina which constituted three-fourths of the mass. The origin of pisolitic ores was in fact organic. In Sweden certain lakes were regularly dredged each year for the pisolitic ore still in course of formation by means of confervoid algæ. He therefore regarded the whole of these beds as in a certain sense sedimentary, and though due to organic agency, yet still deriving their original mineral matter indirectly from the basalt. The basalt contained a considerable amount both of phosphorus and sulphur; and if the ores had been derived directly from the basalt, both these substances would have been present in them. This was an argument against any direct metamorphism. The presence of vanadium afforded additional reason for regarding these ores as formed in the same manner as bog iron and similar ores.

Sir Charles Lyell had observed in the basalts of Madeira red ochreous bands, which represented old land surfaces, in one of which Mr. Hartog and he had discovered a leaf-bed containing vegetation of much the same character as that of the island at the present day. Near Catania, in a recent lava-stream, he had seen the junction of the lava with the soil of the ancient gardens; and in character the soil now under the lava resembled the red beds in Madeira.

Mr. W. W. Smyth was on the whole inclined to admit the power of metamorphism to produce such changes as had been here effected. He commented on the advantages of employing this Irish ore for admixture with hæmatitic ore, on account of the abundance of alumina present. Possibly there had been some difference in the chemical character of the different flows of basalt.

Mr. Evans suggested that the Ballypalidy beds might be the littoral deposits of a lake in which the pisolitic ores of the other parts of Antrim were deposited further from the shore, and subsequently buried under a basaltic flow.

Mr. Etheridge inquired whether the pisolitic ore had been subjected to microscopical examination, with a view of finding traces of organic forms, such as *Gallionella*.

Mr. Tate, in reply, defended his views as to metamorphic action. He thought the uniformity in thickness and character of the pisolitic ore band over so large an area showed that it could not be a lacustrine deposit. He had not as yet examined the spheroids under the microscope.

2. "Notes on the Structure of *Sigillaria.*" By Principal Dawson, F.R.S., F.G.S., Montreal.

In this paper the author criticised the statements of Mr. Carruthers on the structure of *Sigillaria* (see Q. J. G. S. xxv. p. 248). He remarked that *Sigillaria,* as evidenced by his specimens, is not coniferous; that the coniferous trunks found in the Coal-formation of Nova Scotia do not present discigerous tissue of the same type as that of *Sigillaria;* that no Conifer has a slender woody axis, surrounded by an enormously thick bark; that *Calamodendron* was probably a Gymnosperm, and allied to *Sigillaria;* that although *Stigmaria* may not always show medullary rays, the distinct separation of the wood into wedges is an evidence of their having existed; that the difference in minute structure between *Sigillaria* and *Stigmaria* involves no serious difficulty, if the former be regarded as allied to Cycadaceæ; and further, that we do not know how many of the *Stigmariæ* belong to *Sigillaria* proper, or *Favularia,* or to such forms as *Clathraria* and *Leioderma,* which may have been more nearly allied to *Lepidophloios;* that the fruit figured by Goldenberg as that of *Sigillaria* is more probably that of *Lepidophloios,* or may be a male catkin with pollen; and that he has found *Trigonocarpa* scattered around the trunks of *Sigillariæ,* and on the surface of the soil in which they grew. He agreed with Mr. Carruthers in regarding Mr. Binney's *Sigillaria vascularis* as allied to *Lepidodendron.*

Discussion.—Prof. Morris thought that *Clathraria* and *Lepidophloios* ought to be discriminated from the *Sigillariæ,* as being rather more nearly allied with cycadaceous plants, especially the former. He pointed out the manner in which certain vascular bundles, communicating between the centre of the stem of *Sigillaria* and allied genera and their bark, might be mistaken for medullary rays.

3. "Note on some new Animal Remains from the Carboniferous and Devonian of Canada." By Principal Dawson, F.R.S., F.G.S. Montreal.

The author described the characters presented by the lower jaw of an Amphibian, of which a cast had occurred in the coarse sandstone of the Coal-formation between Ragged Reef and the Joggins Coal-mine. It measured six inches in length; its surface was marked on the lower and posterior part with a network of ridges enclosing rounded depressions. The anterior part of the jaw had contained about 16 teeth, some of which remained in the matrix. These were stout, conical, and blunt, with large pulp-cavities, and about 32 longitudinal striæ, corresponding to the same number of folds of dentine. The author stated that this jaw resembled most closely those of *Baphetes* and *Dendrerpeton,* but more especially the former. He regarded it as distinct from *Baphetes planiceps,* and proposed for it the name of *B. minor.* If distinct, this raises the number of species of Amphibia from the Coal-measures of Nova Scotia to nine.

The author also noticed some insect remains found by him in slabs containing *Sphenophyllum*. They were referred by Mr. Scudder to the *Blattariæ*.

From the Devonian beds of Gaspé the author stated that he had obtained a small species of *Cephalaspis*, the first yet detected in America. With it were spines of *Machairacanthus* and remains of some other fishes. At Gaspé he had also obtained a new species of *Psilophyton*, several trunks of *Prototaxites*, and a species of *Cyclostigma*.

DISCUSSION.—The President objected to the term Reptiles being applied to *Amphibia*, from which they were totally distinct. He questioned the safety of attributing the jaw to *Baphetes*, of which no lower jaw had been previously found.

Mr. Etheridge remarked that the *Cephalaspis* differed materially in its proportions from any in either the Russian or British rocks.

4. "Note on a Crocodilian Skull from Kimmeridge Bay, Dorset." By J. W. Hulke, F.R.S., F.G.S.

The author described a large Steneosaurian skull in the British Museum, from Kimmeridge Bay, which had been previously regarded as Pliosaurian, and was recently identified with *Dakosaurus* by Mr. Davies, Sen. From the agreement of their dimensions, and their occurrence near together, the author thought it probable that this skull and the lower jaw described by him last session belonged to the same individual. It differs from the *Steneosaurus rostro-minor* in the greater stoutness of its snout, in the presence of an anterior pair of nasal bones prolonged into the nostril, and in the number of its teeth. The author proposed to name it *Steneosaurus Manseli*, after its discoverer.

5. "Note on some Teeth associated with two fragments of a Jaw from Kimmeridge Bay." By J. W. Hulke, F.R.S., F.G.S.

The author described some small teeth, associated with fragments of a long slender snout, not unlike that of an Ichthyosaur, but too incomplete to be certainly identified. The teeth are peculiar in the great development of the cementum, which gives the base of the tooth the form of a small bulb. The exserted crowns are slightly curved, smooth, cylindrical, and pointed. The attachment to the dentary bone was probably by means of the soft tissues, and the teeth seem to have been seated in an open groove in the surface of the jaw-bone. Until additional material reveals the true nature of this fossil, the author proposes to place it alone, and to call it provisionally *Euthekiodon*.

II. January 12th, 1870.—Prof. Huxley, LL.D., F.R.S., President, in the Chair. The following communications were read:—1. "On the Geological Position and Geographical Distribution of the Reptilian or Dolomitic Conglomerate of the Bristol Area." By R. Etheridge, Esq., F.G.S., Palæontologist to the Geological Survey of Great Britain.

The author noticed the history of our knowledge of the Dolomitic conglomerates of the Bristol area from which the remains of Dinosaurian reptiles have been obtained, and then described their mode of occurrence and distribution over the district near Bristol. He regarded these deposits as due to the action of the sea-waves of the later or Middle Triassic periods upon the rocks of older Triassic (Bunter) or Permian age, during the gradual elevation of the land, and as the probable representatives in point of time of the Muschelkalk, otherwise deficient in Britain. The author then noticed the influence of the conglomerate upon the production of certain minerals, such as calamine and hæmatitic iron-ores, and discussed at some length the probable course of the phenomena of denudation which furnished the materials for the formation of the conglomerate at different levels, in which he recognized two great periods of oscillation, the first witnessing a downward movement of the Palæozoic lands, and lasting throughout the deposition of the New Red Marl and Sands, and the second, during which the accumulations of the former were again, at least partly, denuded. With regard to the time at which the remains of Thecodont reptiles were imbedded in the conglomerate, the author inferred from the evidence that this took place late in the period of the Keuper.

Discussion.—The President inquired on what ground the author considered these reptiles to belong to a late period in the Keuper, and was informed that the author spoke especially with relation to the Keuper of the Bristol area, of which the beds containing them occupied the highest position.

Prof. Ramsay considered these conglomerates not merely as of marine origin, but as breccias which had covered the old land surface which had been worked up by the water of the New Red Period. He objected to the term Sea having been introduced into the paper, as, though the tracts may have been islands and promontories, and though the water which surrounded them was salt, there was no open sea, but merely a large inland salt-lake, in which the New Red Marl was formed. The marl was less connected with the New Red Sandstone than with the Lias. The Muschelkalk being absent, it was constantly the case that the marl rested immediately on the palæozoic rocks without the intervention of the Bunter Sandstone. He thought that there were good grounds for connecting the Rhætic beds with the New Red Marl below and the Lias above. The probability was that the change in character was due to a gradual influx of the sea into the inland lakes. He thought that the Thecodont Saurians might also eventually be found even in beds of Liassic age.

Prof. T. Rupert Jones remarked that Mr. Tawney and Dr. Duncan had already intimated the St.-Cassian aspect and character of the Sutton beds. The freshwater character of some of the Keuper beds was, he remarked, indicated by the presence of *Estheriæ*; and he alluded to the fact of the Bristol palæosaurians having been erroneously used as Permian characteristics in Russia and Carolina.

Mr. W. Boyd Dawkins had found at Cheddar that the Dolomitic conglomerate formed two great tongues running up ravines in the older rocks, which had probably been due to subaërial action.

Prof. Morris alluded to some sections which seemed to corroborate the views of Mr. Etheridge, and pointed out the relation of the conglomerate beds to the overlying strata at those points. He also mentioned certain peculiarities in the structure of the conglomerate itself.

Mr. Etheridge stated in reply that the Marls in the Bristol area were the exception, the greater part of the New Red beds being sandstone.

2. "On the Superficial Deposits of portions of the Avon and Severn Valleys and adjoining Districts." By T. G. B. Lloyd, Esq., C.E., F.G.S.

The author, after describing the general characters of what he termed the Drifts of the Upper and Lower series, and the [illegible] water gravels of the Lower Avon, comprised within the [illegible] of the Avon valley between Tewkesbury and Rugby, and of the Severn valley above and below the town of Worcester, endeavoured to show that there was a balance of evidence in favour of the existence of an upper and lower platform of drift in the main valley of the Lower Avon, the upper one being of marine origin, and probably belonging to the same epoch as the stratified beds of gravel in the neighbourhood of Worcester, which contain marine shells and mammalian remains, whilst the lower one, of freshwater origin, had been derived from the former by fluviatile action, as supposed by the late Prof. Strickland. Further, that there was no evidence to warrant the supposition of the existence of high and low-level river-gravels in those portions of the Severn and Avon valleys under review, and that the apparent absence of any freshwater shells in the gravels of the Severn valley between Bridgnorth and Tewkesbury led to the inference that the freshwater gravels of the Avon were not represented in the adjoining portions of the Severn valley, although remains of some of the same species of mammalia occurred in both localities. After stating his opinion that the time had not yet arrived for indulging in theoretical speculations concerning the phenomena of the Drifts of the Upper and Lower series, exhibited in so small an area as the one under consideration, the author concluded by expressing hopes that the facts which he had brought forward would contribute their share of help to the further elucidation of the question.

3. "On the Surface-deposits in the neighbourhood of Rugby." By J. M. Wilson, Esq., F.G.S.

The author commenced by noticing the general configuration of the surface of the district under review, which he stated to consist of an elevated plateau, bounded and rendered irregular in its outlines by valleys. The district consists chiefly of Lower Lias, with a few patches of Middle Lias. The surface-deposits on the plateau, and on similar high lands in the neighbourhood, consist of:—1. Flinty or quartzose drift; 2. Sugary sand, with grains of chalk; 3. Clay, with pebbles, principally of chalk, and distinctly striated. The valleys bounding the plateau were described as belonging to two systems, those of the Avon and Leam. The bottom of each valley is generally a narrow strip of alluvial soil, bordered by sand in some places, and by drift in others. The author has bored down into the surface-deposits in the valley of Low Morton. In one boring, which reached a depth of 53 feet, he stopped in a greyish clay containing chalk-particles; in another, through similar clay, to a depth of 57 feet, the rock was reached, and fragments of limestone were brought up.

DISCUSSION.—Mr. Searles V. Wood, Jun., had long been aware of the existence of the Middle Glacial Sand near Rugby. He pointed out the difference in the fauna of the sands of the Severn valley below the glacial clay and those of similar deposits in the east of England, but thought they might, notwithstanding, be of the same age.

Mr. Gwyn Jeffreys was doubtful as to the authenticity of some of the shells which had been brought to Mr. Maw. The fossil shells from the Severn valley, Wolverhampton, Manchester, and Moel Tryfaen, were nearly identical, and indicated raised beaches. He thought it possible that a definite line of such beaches might eventually be recognized through that part of England.

Mr. W. Boyd Dawkins did not consider that there was any marked difference in the mammalian fauna of the Avon and Severn valleys. He had failed to discover any traces of *Elephas antiquus* in either.

Mr. Prestwich thought that the author had probably divided the superficial beds into too many separate deposits, though the facts brought forward were of great value.

Mr. Evans mentioned that he had received information of the discovery many years ago of a flint implement in association with the bones of extinct mammals at Lawford. This implement had been exhibited at the time to the Geological Society, but had disappeared after the meeting.

Mr. Lloyd and Mr. Wilson briefly replied.

GEOLOGISTS' ASSOCIATION, December 3rd, 1869.—Prof. Morris, President, in the chair. Mr. S. R. Pattison, F.G.S., gave an account of the Geology of the Huelva District, in the South of Spain, which he had recently visited. After a rapid sketch of the general geology of the peninsula, noticing the great east and west mountain ridges, with wide intervening table-land and plains, he described the Granite of Old Castile, which is variously decomposed, bouldered, and drifted; then the ridge of the Toledo Mountains; and, finally, that of the Sierra Morena, distinguished by stronger mineralization; and the Tertiary plains of the Guadalquivir. After quitting Seville, and reaching the banks of the River Tinto, at the fine old fortified town of Niebla, Red Sandstone is met with, including huge masses of limestone, worked for economical purposes. Again descending into the Tertiary plain, the Miocene cliffs around the town of Huelva were alluded to, and then the course of the Buitron Railway, from St. Juan by Trigueros. The pale southern Tertiaries are here covered with deep red gravel and sand. Rising with the slope of the country, towards the Sierra, the road enters a district composed of wavy hills of coarse grits, shales, and schistose rocks, with frequent patches of greenstone. There does not appear to be any limestone, nor were any fossils seen, save obscure crinoidal stems. The whole series is treated as Silurian in the only geological maps known. The strike of the rocks and of the chains of wave-like barren hills is east and west, the bedding nearly vertical, frequently varying, with small folds, and a general northerly dip. The pink-red stains soon betray the presence of manganese, hillocks of which are seen on the wharves at the stations ready for transit. The manganese occurs, as is usual with this mineral, in bunchy deposits, coincident with the bedding of the rocks. At Valverde the rocks become more talcose, and quartz veins are numerous. The same coarse and thin-bedded schists continue, with greenstone running with the strike, until a double line of low stones is seen at intervals crossing the country; these are the *saal-bands*—vein-walls, which extend in the direction of the strike. Between these are deposits or strong veins. Wherever the surface is reddened by oxide of iron, called by the Spaniards, "Colorados," the depth is occupied by a mass of pyrites. Besides this indication, there is invariably the trace of old workings, called Roman, and, probably, executed under Roman dominion. There are, at Buitron, for instance, ancient sinuous galleries, through which the best portion of the ore at the upper surface of the deposit has been extracted. There are also shafts, and, at some little distance, slag-heaps, where the ores have been smelted. The Buitron deposit is a wedge-shaped mass, nearly cut in two by barren ground in the middle. It slightly narrows in descending. The contents are a nearly uniform grey-green ore of copper pyrites, crossed by bands, varying in the percentage of copper. The ore contains about 48 per cent. of sulphur, from 10 to 20 per cent. of iron, from 1 to 5 per cent. of copper, and some silica in a finely divided condition. It is either sent to England as it is dug out of the mine, or treated by cementation, as it is called—burnt by its own sulphur in the open air, and the burnt ore treated for the copper. The precipitates are also obtained by the usual processes. The lead is also saved, but is inconsiderable. Another process is sometimes used (though not at Buitron), suitable only to ores containing under 2 per cent. of copper, called kernel roasting, whereby the copper is by very slow combustion driven to the centre. The Buitron mass may be classed with the great deposits on the same parallel, the Rio Tinto, the Tharsis, and the San Domingo. These masses of pyrites are from 50 to 1200 fathoms long, and from 3 to 50 fathoms broad between the walls. The mass of mineral in the vein has sunk, owing to the process of oxidation by air and water, leaving the walls standing out above the surface in a most remarkable manner. The wash from the surface of these masses deposits hydrated oxide of iron. The whole range of the deposits, occasionally metalliferous in irregular portions, is upwards of 140 miles, the lode winds a little in a limited band of country running nearly east and west. The mineral is essentially the same, but richest in copper at Buitron, near the disturbed edge or side. The coarse schistose rock is not much metamorphosed, except in certain places near the greenstones. The successions are very thinly bedded. In none of these rocks does there appear to be any true slaty cleavage, though there are occasionally good slate flagstones. The literature of this subject may be found in Mr. Mason's original pamphlet on the Mines of Huelva; in one or two Spanish reports; Mr. J. L. Thomas's pamphlet on the Rio Tinto Mines; and Mr. Green's able description in the Quarterly Journal of Science for October, 1868.—The great commercial importance of these deposits arises from the demand in Great Britain for these ores for their contained sulphur. They are used at Newcastle and elsewhere in the manufacture of sulphuric acid for artificial manure. The trade is of considerable dimensions, amounting altogether to the raising and exporting, from all the mines, of upwards of 500 tons a day, and for this three railways have been constructed.

CORRESPONDENCE.

"PHOLAS" HOLES IN LIMESTONE.

Sir,—I am unwilling to let the month pass without acknowledging the weight of the Rev. T. G. Bonney's observations (on pp. 483, etc.) on certain notes of mine on some superficial phenomena at

Great Orme's Head, and especially on the identification, as burrows of "Pholas," of certain holes in limestone there and elsewhere. The question of the correctness of this determination is of some importance and of real difficulty; but I believe that fuller discussion will only confirm the reference of these holes to Pholas, or some similar animal, to the exclusion of Helix; and I hope to submit some further illustration of this subject shortly.

In the meantime allow me at once to prevent from lending undue support to my own side of the argument an apparent confirmation of the Pholas theory, which appears in p. 494, at the end of Mr. De Rance's paper. There is an error in the identification with the specimen holes under discussion of the holes in blocks of Carboniferous limestone from the sea beach at Walney Island, "in each of which may be seen the two perfect shell valves of a Pholas." Such a discovery would go far to settle the question. I have, however, with Mr. Bolton's permission, just examined the stones referred to. They are beach boulders of limestone, which, as Mr. Bolton explained to me, were imported from some place in Wales to be burned for hydraulic lime in connexion with certain works at Barrow. The shells are not Pholas, but the common *Saxicava rugosa*, quite recent.

Specimens of *recent* Pholas holes in *limestone* are by no means of frequent occurrence. My own series is not yet completely satisfactory; and if any reader of the GEOLOGICAL MAGAZINE knows of a locality where such specimens can be obtained, with living or lately dead *Pholades*, I should be greatly obliged by his indicating it to me.

R. D. DARBISHIRE.

26, GEORGE STREET, MANCHESTER,

SIR,—I think that Mr. Mackintosh must have read my paper, in Vol. VI., p. 483, rather hastily, or he would not have said that I was not "fortunate in meeting with very perfect specimens of lithodomous perforations on the Llandudno Peninsula." Those which I describe on page 487 are called "fine burrows . . . . one small, the other about 2½ inches deep, and more than an inch in greatest width." Again, I speak of the burrows found within the crevice as "perfectly smooth, fresh, unweathered . . . . all of them completely protected from the weather." Will Mr. Mackintosh explain how Pholades could produce holes of this kind, varying from half an inch to an inch in depth, and about an inch in width, on the *roof* of a horizontal crevice, about an inch wide. With regard to the case, which he quotes in a note, of seventeen land shells being taken from one burrow, I can only say that, having never studied the politics of the "Helical State," I do not know what their laws of division of labour may be. Probably, being easy going animals, they are less actively selfish than those of a higher grade, and do not trouble themselves when it happens that one works and another shares the fruits of his labour. I may add that in the case which Mr. Rofe mentions (Fig. 1 of my plate) there were no signs which would lead me to suppose that any considerable portion of the rock had been removed, so as to expose a vertical section of any burrow, though of course this might happen. I do not think it had so done in this case.

T. G. Bonney.

Sir,—To the many explanations offered on Lithodomous Perforations, may I be allowed space to say, that in searching for *facts* in Geology in the Furness district, I met with a bed of slate-coloured clay on the sea-shore, about half way between high and low water. This clay was much bored, and the holes contained *live* Pholades, and apparently at work. Suppose in time this clay becomes embedded and changed into rock, and afterwards by some convulsion of nature is thrown to the surface, may it not be possible for the action of the atmosphere, rains, etc., to not only destroy the remains of the original makers of the holes, but alter the appearance of them, and the holes become useful winter homes for land snails.

I have seen the rocks at Ormeshead and other places in Wales, and more than 20 times those on Birkrigg, but after careful examination, cannot see how the explanations hitherto given fully account for the borings.

Samuel Salt.

Ulverston, 10*th January*, 1870.

TERRACES ON INLAND SLOPES.

Sir,—I am glad to see, from the reply of Mr. Mackintosh in your last number, that he no longer ventures to "assert" the marine origin of these terraces, though he still "believes" that the greater number of them are "Sea-worn." I will, however, suggest to him that even such a modified "opinion," considering the importance of the theory which it involves as to the very recent emergence of this whole island from beneath the sea, requires an array of facts in its support of which his book does not afford a single specimen.

One word upon my "descent of silt theory," which Mr. Mackintosh still cannot, in any case it seems, admit; but which I look upon as possessing a real interest to geologists who are speculating on the causes which have modelled the existing surfaces, as showing how large an amount of change the atmospheric forces, coupled with that of gravitation, can produce within a very limited time.

It is clear that Mr. Mackintosh will not yet comprehend that the wash of rain on a plough-disturbed surface *must*, and *does*, carry down by degrees a large amount of silt, or disintegrated soil, to some lower level, where the force of the current sustains a check, and the solid matters are deposited. If he will only look at a recently ploughed slope, after a heavy rain-storm, he will *see* this process exemplified in an unmistakable manner. He speaks of "ridges artificially formed as boundaries between fields," as "distinct from the terraces under consideration." Of course they are so, if he refers to banks of earth raised high above the ground on *both* sides, such as are common in Devonshire and some other counties. The "terraces under consideration" are uniformly flat, or nearly so, on the upper side, and rest on a steep bank fronting the lower side.

And these, whether there still exists a force to check the further descent of silt, or that this has been removed, or *never existed there at all*, are, I venture to maintain, the result of the process I have described. And of this even Mr. Mackintosh, I think, will convince himself, if he will only cut through a few of them, and fairly examine their composition.

Of course I must not be understood as denying that many banks in valleys have been formed on either side of a running stream by its erosion, whether during floods, or when the stream ran at a higher level than at present. It is the "marine" origin of the terraces in question, to be seen scoring the flanks of our Chalk and Oolite hills, often up to their summits, which I have controverted. And although Mr. Mackintosh has now withdrawn the phrase "raised sea-beaches," as applicable to them, and substitutes those of "raised coast-lines, tidal terraces, or current-marks" (p. 26 *supra*), I do not think he thereby mends his position in any degree.

G. Poulett-Scrope.

GLACIAL EPOCH IN NEW ZEALAND.

Sir,—I observe that several writers who discuss the debatable land between Geology and Physical Geography assume that in the Southern Hemisphere signs are found of a Cold Period, analogous to the Glacial Period of the North, and any difference of opinion on the subject is only as to whether the extreme cold affected both hemispheres at the same time, or alternately. I am aware that descriptions of this Glacial Epoch, and the formations by which it was supposed to be recognized in New Zealand, was given by Dr. Haast, prior to 1864; but towards the close of that year he completely changed his views on this most vital point in New Zealand Geology, and adopted the explanation of the former extension of the Glaciers in the New Zealand Alps, which was first suggested by myself in 1863.

Those who are interested in this subject will find the more modern view fully stated in the English translation of Hochstetter's work, the essential points being given in my own words (Hochstetter's New Zealand, 1867, p. 505). As the author does not give this important passage as a quotation, reference may be made to the Journal of the Royal Geographical Society, 1864, p. 103; while at page 92 of the same volume of the Journal, the opposite hypothesis of the submergence of the island and contemporaneous ice-cap during a Glacial period, is clearly stated by Haast.

This latter theory is quite irreconcilable with the observed facts, and the former extension of the glacier is sufficiently accounted for by the gradual reduction of the surface area exposed above the perpetual snow-line: firstly, by its erosion into valleys, ridges, and peaks; and secondly, by its gradual subsidence—a subsidence which has operated for the most part continuously—though interrupted by irregular and local elevations. Some of these have occurred since the arrival of colonists, even to the extent of nine feet. But beyond fifteen to twenty-five feet above the present sea level, no marine deposits are found of later date than the Pleiocene. The Pleistoc deposits in New Zealand are sub-aërial, with the exception of raised beaches referred to, and the evidence of progressive s mergence is discovered in the contour of the land above and bel the sea level, submerged forests, and other indications of unmistal able import.

JAMES HECTOR.

Geological Survey Office, Wellington, New Zealand,
31st October, 1869.

ON THE OCCURRENCE OF SCHORL IN DRIFT, NEAR OXFORD.

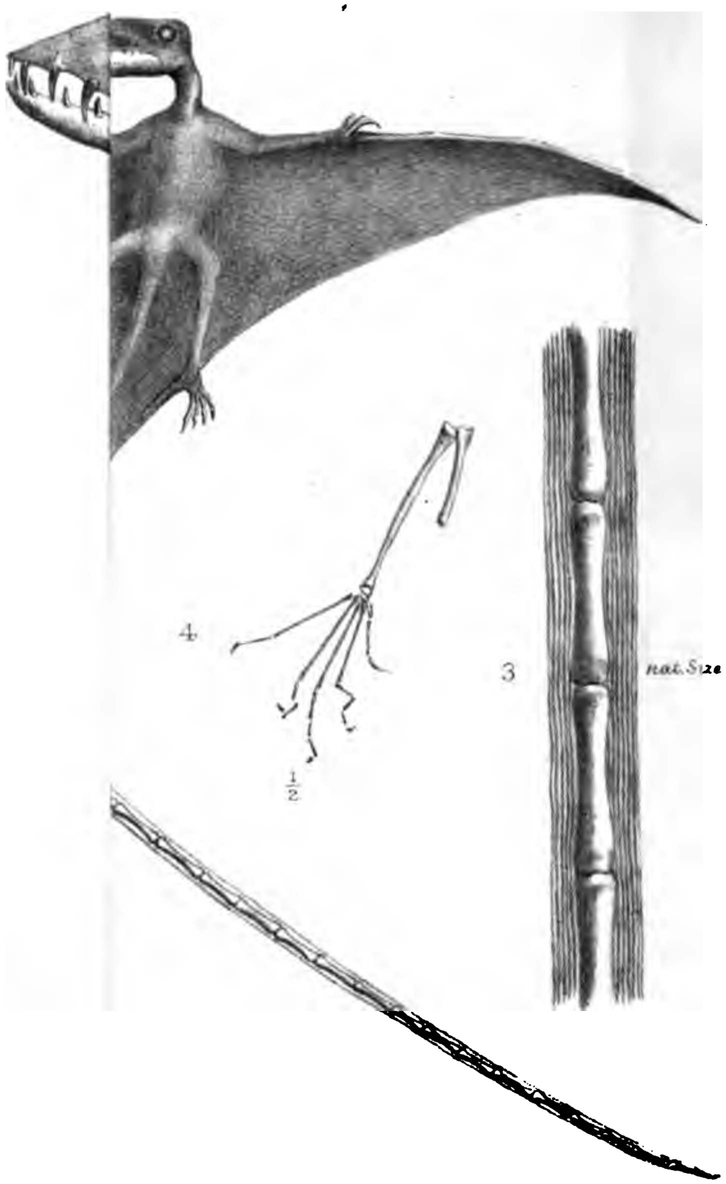
SIR,—A small pebble of quartz was found by my brother a fe years ago at Sandford upon Thames, near Oxford, having a blac spot on its surface. On breaking it, I found that it contained th termination of a small crystal of Schorl, or black Tourmaline. It may possibly have been derived from the North-west of England. Tourmaline, according to Greg and Lettsom, does occur at Tenter Gill, Carrock Fells; also at Saddleback, near Force Crag. I have given the specimen to Professor Phillips, at Oxford.

S. G. PERCEVAL.

HENBURY, *5th January*, 1870.

OBITUARY.

FREDERICK COLLIER BAKEWELL, a well-known writer on geological and physical science, died 26th September, 1869. He was the son of Robert Bakewell, the eminent geologist, whose "Introduction to Geology," published first in 1814, was the earliest comprehensive work on this subject. Mr. F. C. Bakewell was very early connected with the Press, having been editor of the now almost forgotten *Courier*—the *Times* of its day—and later, as scientific writer for the *Morning Post* and *Daily News*, etc., in which capacity for many years he attended the meetings of the "British Association for the Advancement of Science." His earliest work was "Philosophical Conversations," a practical introduction to every-day science for young people; and in 1835 he published "Natural Evidences of a Future Life," which he was revising for the press at the time of his death, and which will shortly appear in a new edition. Among his other works were "Electric Science, its History, Phenomena, and Applications" (1853); "Geology for Schools and Students;" "History of Modern Inventions," etc. He interested himself recently in a discussion as to the Shape of the Earth at the Poles; and in 1867 published a small pamphlet entitled, "A Dynamical Theory of the Figure of the Earth," a brief notice of which was given in the GEOLOGICAL MAGAZINE, Vol. iv., p. 430. Mr. Bakewell possessed an extraordinarily inventive genius, and occupied himself in the construction of many interesting and novel appliances. His greatest and favorite invention was that of the Copying Electric Telegraph, for which he was awarded the Council Medal at the Exhibition of 1851, some modification of which will probably, sooner or later, be adopted for the transmission of messages.



G R. De Wild
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THE
GEOLOGICAL MAGAZINE.

No. LXIX.—MARCH, 1870.

ORIGINAL ARTICLES.

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I.—British Fossils.[1]

By the Editor.

(PLATE IV.)

THE Twenty-third volume of the Palæontographical Society's published Monographs has just reached us. It represents the annual volume for 1869; so that, thanks to the energetic exertions of the Honorary Secretary, the Rev. T. Wiltshire, M.A., F.G.S., we have now ten months during which the volume for 1870 may appear, thus bringing the date of issue once more even with the current year's subscription.

Such being the healthy state of the Society, we trust that the Treasurer (like our present Chancellor) will not tolerate arrears, for every year the volumes issued by this Society become more and more valuable, and doubtless very soon they will be at a premium. The present issue contains:—

1. Supplement to the Fossil Corals. Part II. No. 2. (Cretaceous Corals.) By Dr. P. Martin Duncan, F.R.S., &c. (Six Plates, pp. 20.)
2. The Cretaceous Echinodermata. Vol. I. Part 3. By Dr. T. Wright, F.R.S.E., F.G.S. (Ten Plates, pp. 13.)
3. The Belemnitidæ. Part V. Oxford Clay Belemnites, &c. By Prof. Phillips, M.A., F.R.S., &c. (Nine Plates, pp. 19.)
4. The Fishes of the Old Red Sandstone. By Messrs. J. Powrie and E. Ray Lancaster. Part I., *concluded.* The Cephalaspidæ. By E. Ray Lancaster, B.A. (Nine Plates, pp. 29.)
5. The Reptilia of the Liassic Formations. Part II. By Prof. Owen, F.R.S. (Four Plates, pp. 40.)
6. The Crag Cetacea. No. 1 (*Ziphius*). By Prof. Owen, F.R.S. (Five Plates, pp. 40.)

Out of such a series of interesting Monographs it would seem invidious to make a selection of one as more deserving of notice than another; but as we propose to refer to this volume in a future number, we will only select one paper this month for especial notice —that by Prof. Owen upon the *Pterosauria* of the Lias.

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[1] Monographs published by the Palæontographical Society, vol. xxiii. Issued for 1869. London: February, 1870. 4to., pp. 279, and 43 Plates.

Although remains of Flying Reptiles have long been recognize as occurring in the Lias, the Stonesfield Slate, the Greensand, an Chalk of Britain, yet their presence has been indicated only b detached bones—a jaw with teeth, or a skull more or less entire—by the help of which, however, that skilful comparative anatomist Prof. Owen, has been enabled to prove the existence, in Britain, i Mesozoic times, of volant reptiles far surpassing in magnitude thos marvellously perfect remains of Pterodactyles from the Solenhofe stone.

So long ago as 1829, Dr. Buckland communicated the discover of parts of the skeleton of *Pterodactylus macronyx*, from the Lias o Lyme Regis, to the Geological Society of London (Trans. Geol. Soc 1835, 4to. Vol. III.).

Later (in 1858), Prof. Owen described the head, &c., of probabl the same species, which he then named *Dimorphodon*.[1]

After an interval of ten years more, Mr. Henry Woodward, whe visiting Lyme Regis in March, 1868, observed in the collection o the late Mr. Henry Marder, M.R.C.S., an entire series of caudal vertebræ, 20¼ inches in length, surrounded by ossified fibres o tendons, so as to form a slender rod-like, and almost inflexibl rudder, closely resembling the tail of *Rhamphorhynchus* from th Solenhofen stone. The specimen was at once secured for the British Museum. In the following August, the Earl of Enniskillen sent up from Lyme Regis a slab of Lias (obtained by Mr. James Marder, o Lyme), containing the greater part of the bones and head of *Dimorphodon*, showing that the remains previously described by Dr. Buckland in 1829, and by Prof. Owen in 1858, really belong to one species, and, what is also very interesting, displaying remains of a caudal series of vertebræ, identical with those forming the entire detached tail obtained from Mr. Henry Marder.

Thus, after an interval of forty years, Professor Owen has been enabled to reconstruct and present to palæontologists a complete figure of this truly remarkable type of British Pterodactyle. The anatomist who, with a box of recent bones before him, sets to work to build up the skeleton of a bird, or of a quadruped, finds his task difficult; but how vastly more difficult the task, and more skilful must be the comparative anatomist who would rehabilitate the scattered framework of one of the ancient denizens of our world, the fashion of whose very skeleton is now gone out of date, and has no living analogue with which we may compare it. Such is the task Prof. Owen has performed, and we cannot but feel a pleasure that so rare a fossil has been rescued for the benefit of science.

Dimorphodon macronyx, as we are now able to read it, by the light of Prof. Owen's monograph, differs in a remarkable manner from the long-tailed flying lizard of Solenhofen (*Rhamphorhynchus*), not only in the form of its head, but also in the proportions of the hind-limbs.

In *Dimorphodon* the hind-limbs are large, and evidently capable of supporting the body, both in climbing and crawling; the feet are also well developed. In *Rhamphorhynchus*,[1] on the contrary, the hind-limbs are almost rudimentary (see Plate IV. Fig. 4), and could have been but feeble organs, either for walking or climbing, as compared to the hind-limbs of *Dimorphodon* (Plate IV. Fig. 1).

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[1] Reports (Sections) British Association, Leeds Meeting, 1858, p. 97.

The skull and jaws of *Dimorphodon* differ remarkably from every other *Pterodactyle* at present known. The head is large in proportion to the trunk, not only in respect to its length, but more especially in its depth, and probably also in breadth. The two crania preserved in the British Museum both show the profile very fairly perfect, and both exhibit the great depth of the head; "nevertheless," writes Prof. Owen, "the shape and disposition of the bones are such that, perhaps, no other known skull of a vertebrate is constructed with more economy of material—with an arrangement and connection of bones more completely adapted to combine lightness with strength."

In *Rhamphorhynchus* the anterior portions of both the upper and lower jaws are edentulous, and from their shape Hermann Von Meyer has inferred that they were covered by horny sheaths, like the beak of a bird. In *Dimorphodon*, on the contrary, the jaws throughout are armed with a combination of laniary teeth, and more closely set and smaller serial teeth in the lower jaw.

Referring to Dr. Buckland's original paper in the Geological Transactions, it is extremely interesting to note that with the limb-bones there are also figured two or three of the long slender caudal vertebræ imbedded in osseous fibres; these, however, were regarded by Dr. Buckland as cervical. "The tail," he observes, "was probably longer than in *P. longirostris*, and may have cooperated with the legs in expanding the membrane for flight:—a long and powerful tail is in strict uniformity with the character of a lizard" (p. 221.) This observation seems quite prophetic, for no long-tailed *Pterosauria* were then known. (See Restoration, Pl. IV. fig. 2.)

Professor Owen gives a careful analysis of the observations of Hermann Von Meyer on the *Pterodactyles* of the Solenhofen stone. That able naturalist and palæontologist is, alas! now no more, but his name and vast labours will be long valued by scientific men.

Von Meyer quotes Oken's opinion, "that the skull in the *Pterodactyle* is intermediate in character between that of the chameleon and crocodile," and thus concludes: "The skull of *Pterodactylus* is essentially comparable only with that of Birds and Saurians. The preponderating resemblance to the bird's skull cannot be contested. Against this, however, is a remarkable dissimilarity in certain parts which, on the other hand, approximates it to the type of Saurians." (Von Meyer, in Owen's Mon. p. 60.)

Professor Huxley, in various papers which he has published, has demonstrated, chiefly on osteological grounds, the close affinity existing between Birds and Reptiles. One of the most important of these papers was read before the Geological Society on the 24th of November, 1869, and appears in the February Number of the Society's Journal. (See GEOL. MAG. January, 1870, p. 36.)

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[1] See Illustrations to paper, by H. Woodward, in the "Intellectual Observer," Vol. ii. 1863, pp. 443-451, "The Flying Lizards of the Secondary Rocks."

Professor Owen is opposed to the union of Birds and Reptiles, and points to their affinity with the Implacental Mammals, in the development of the embryo, in the brain, in the circulating system, etc. He strongly combats the inference that warm blood is an essential accompaniment of an animal endowed with the power of flight, and cites the cockchafer as an instance of a living creature capable of powerful flight, whose body, nevertheless, only raises the thermometer one degree above the surrounding medium. He maintains that the constant accompaniment of hot-bloodedness is a non-conducting covering to the body, and that we may with certainty infer that *Archæopteryx* was *hot-blooded*, because it had feathers, not because it could fly. We think a happier illustration than the cockchafer (so dissimilar in bulk and organization from the Pterodactyle) is that of the shark and porpoise—the former cold-blooded, the latter warm-blooded—both performing the same muscular feats, in following a ship for days, with equal ease. (See Prof. Owen's Monograph, p. 73.)

Space does not admit of our pursuing this interesting subject, but we have said enough, we trust, to show that, taking a single Monograph out of the present fasciculus, forming Vol. XXIII., there is garnered a rich store of palæontological matter for those who care to benefit by the works of this useful Society.

EXPLANATION OF PLATE IV.

Fig. 1. *Dimorphodon macronyx*, Owen (⅛ original). Restoration, copied from Prof. Owen's Monograph in Pal. Soc. 1870, vol. xxiii., pl. 20.

Fig. 2. Probable outline of integument (greatly reduced in size).

Fig. 3. Four of the tail vertebræ of the natural size, showing the fine parallel bony fibres which strengthen and render rigid the slender joints.

Fig. 4. Foot of *Rhamphorhynchus* (½ nat. size) placed, for comparison, with hind limb of *Dimorphodon*, also copied from Prof. Owen's plate.

Fig. 5. Side view of skull of Recent Saurian (*Lyriocephalus*).

II.—ON THE CHARACTER AND COMPOSITION OF LAVAS.

By G. POULETT SCROPE, F.R.S., F.G.S., etc.

I HAVE been gratified by observing of late the appearance among geologists of a more general appreciation of the study of volcanic phenomena,—using that word in its broadest sense, as comprehending not merely the occasional outbursts of vapour, ashes, and lava, but also the action of those subterranean forces, to which alone we are indebted for the existence, now or in former times, of any dry land whatever above the dead sea-level at which the agents of denudation would otherwise maintain the surface of the globe.

Perhaps the tendency of recent writers on this subject has been rather to indulge their imaginations by theorizing on the possible nature of the interior of the earth, than to examine carefully the facts observable on its surface. I venture, therefore, to recal those who show this inclination to wander from the legitimate path of investigation—namely, through the known to the unknown—to the necessity of acquiring some more definite notions than can be said to prevail at present, on the character and mode of production of the hypogene rocks which are exposed at or near the surface, before proceeding to speculate further on the condition of those that possibly exist at great depths beneath it.

Among the facts relating to Volcanic Geology which have not as yet, in my opinion, been satisfactorily determined by observation, although freely open to it, I may mention, as especially deserving of examination, the character and composition of lavas, as they exude from the vents or fissures opened for their issue through the solid crust. In the year 1856 I read before the Geological Society of London a paper on this subject (as well as on the mode of formation of Volcanic Cones and Craters), which does not appear to have attracted much attention from Geologists, but which I think contained suggestions worthy of their consideration. (See Quart. Journ. Geol. Soc., vol. xii., p. 338.) If, indeed, we wish to form any reliable opinion upon the nature and character of the subterranean matter underlying the sedimentary rocks, surely a close examination of those portions of this matter which are in so many places rising to the surface and spreading themselves over it, is indispensable.

In the paper above referred to I showed how little foundation there is for the generally received opinion that all lavas, as they issue from a volcanic vent, are in a state of complete fusion, like melted glass or metal. and that it is only through a process of slow cooling they afterwards assume a crystalline texture. I pointed out that there is good reason on the contrary for believing that the greater number, if not all, of the crystals observable in lava after cooling and hardening, (and the microscope discloses them where they are not visible to the naked eye), existed there in a more or less complete form previously to its emission. Some of the facts mentioned in support of this view I may briefly recapitulate. Such are, the extremely stiff and tenacious character of most lavas, as they issue at a white heat from the volcanic orifice, making it difficult to thrust a pointed iron rod into them; the absence of a vitreous texture, even in their superficial portions, or in the scoriæ, torn seething hot from the surface of the liquid matter within the vent by gaseous explosions; the instantaneous consolidation of exposed surfaces in cellular or porous slabs or cakes, which on fracture are found to have the same crystalline texture as the interior of the current; the cracked and more or less vitrified aspect of the felspar crystals of many trachytes; the broken and dislocated appearance of the leucites, felspars, and other crystals in many basalts; the frequent arrangement of the longest axes of such crystals in the direction of the rock, that is, of the movement of the lava when liquid; the finer grain often exhibited towards the tail or extremity of a current than at its source, as if the crystals had been broken up by friction as the matter moved on; the brecciated lavas which appear to have enveloped numerous fragments of the same equally crystalline material without any fusion even of their finest angles, etc.

Of course in these remarks I am referring solely to those lavas which after cooling exhibit a crystalline texture; not to the vitreous lavas, such as the obsidian and pumice streams of the Lipari Isles, Japan, the Andes, Hawaii, and Bourbon, or the Pearlstones of Hungary and and South America. The very fact of the existence of these vitreous lava-flows—having a glassy texture not only on their surface but throughout their mass—affords a negative proof that the stony and crystalline lavas could not have been ejected in the same state of complete vitreous fusion as the former, or why are they not equally glassy and homogeneous throughout, having evidently cooled under the same circumstances of exposure to the atmosphere? In the Lipari Isles there are to be seen thick currents of obsidian and pumice side by side with lavas, produced by the same volcano, composed of an aggregation of interlaced crystals, chiefly labradorite, as large as those of ordinary granite. A rock very similar to this latter composes the mass called the Monte Olibano, near Puzzuoli, seventy feet in thickness, which has flowed over beds of loose ashes from the crater of the Solfatara into the sea. Though scoriaceous near its surface, it is as largely crystalline there as in the interior of the rock.

But, it may be asked, if lavas are already crystalline when they issue from a volcanic vent, how is their fluidity to be accounted for? I reply, Firstly, that lavas vary greatly in this character; some, though extremely viscous, having the fluidity of honey or of mud, so as to flow rapidly down a steep slope, and spread, on moderately flat surfaces, into wide and thin sheets; others possessing such a low degree of liquidity as to coagulate in thick beds (like that of Olibano just referred to,) even on very steep slopes, and, when emitted upon a nearly level surface, to accumulate in bulky hummocks over and around the vent, such as the Puy de Dome and the neighbouring trachytic bosses in Auvergne. It will be found on examination, I believe, a general fact, that the more crystalline lavas show signs, in their bulky forms and other circumstances, of their having been less liquid when propelled from the vent than the more fine-grained; and also that the vitreous lavas exhibit marks of the greatest fluidity —other circumstances, especially their specific gravity, being the same. For it is certain, as might indeed be expected, that the heavier basic or augitic lavas have generally spread further and in thinner beds than the lighter, or acid (trachytic) ones.

Secondly. So long ago as 1825, in the first edition of my Treatise on Volcanos, I suggested that the fluidity of lavas, even when composed for the most part of ready-formed crystals or granules, might be accounted for by the presence, throughout the mass, of a certain amount of interstitial water—of course at the temperature of the lava itself, and therefore probably in the state of minute globules, such as the experiments of M. Boutigny exhibited, and tending to flash into steam on the least relaxation of the pressure upon them. Hence the vesicles and air cells that form in the upper portions of lava streams, and often burst from them in jets of vapour. Hence, too, the instantaneous cooling and consolidation of these exposed portions; the escaping steam carrying off an immense amount of caloric. The finer the grain the more readily would the struggling vapour be enabled to collect and rise in bubbles, and hence the more vesicular structure of the glassy lavas; while in those of coarser or more crystalline grain, the expanding steam would be likely to remain longer entangled in the magma, causing it to assume a spongy or loosely granular texture, and to swell up like a mass of dough or paste in an oven; while the vapour would ultimately escape by filtration through the pores of the rock, rapidly consolidating on exposure, and splitting up by the formation of shrinkage cracks into such rude prismatic blocks or cakes as are seen to characterize the surface of lava-streams of this coarse grain.

One word upon the varying mineral and chemical characters of Lavas. I cannot but think that far too much importance has been attached to these distinctions, especially by the German geologists. By many of these, as in the instance of Baron von Richtofen, whose classification of Volcanic Rocks was lately reviewed by me (GEOL. MAG., Vol. vi., p. 518), these differences, in their minutest peculiarities, have been laid down as determining the relative age of the respective rocks. There can be no greater source of error. It is certain that many varieties of trachyte and basalt, and rocks of intermediate mineral character—that is to say, with a greater or less proportion of acid or basic elements in their composition—are often found succeeding each other as products of the same volcano, in no definite series; sometimes one class, sometimes another, having been first ejected. Nay, they are to be seen occasionally, though rarely, to pass into each other in the same mass, just as some granites are found locally passing into syenite, and this again into greenstone. There are even lavas, as for example that called Peperino, so much employed in buildings at Naples, in which zones or lenticular blotches of different mineral character alternate throughout the rock, the augitic matter having apparently separated itself from the more feldspathic by a process of segregation during the efflux of the lava. And there need be little doubt that what has taken place in this instance on a small scale has frequently occurred on the large one, within the focus of a volcano, during the, perhaps repeated, processes of alternate fusion and re-crystallization, to which a mass of subterranean lava has been probably exposed, under varying circumstances of temperature and pressure. (See Volcanos, pp. 129–132.)

If these views are correct—and it is for younger field-geologists than myself to prove or disprove their truth by a close examination of volcanic districts—they cannot but throw much light on the nature and character of the heated material that underlies the crust of the globe, and makes itself known, both in outward flows of lava, and in the penetration of the fractured crust, by intrusive veins, dykes, and protruded bosses of crystalline rock—in the deeper-seated syenites, granites, porphyries, and serpentines, no less than the trachytes, greystones, and basalts of sub-aërial eruptions. I hope, therefore, to be excused for repeating here ideas on this subject, formed half a century back, and published almost as long; but which still ask for corroboration or disproof from more competent observers. They have, I venture to think, an important bearing on the history of the changes traceable on the surface of our planet, and ought to be worked out, before any justifiable attempt can be made to solve the problem of its sub-cortical character.

P.S.—While the above was going through the press I have read the paper on the Liquefaction of Rocks, by Dr. Sterry Hunt, in the February number of this Magazine. My thanks are due to Dr. Hunt for the generous manner in which on this, as on former occasions, he has acknowledged, and even taken pains to vindicate for me, such small merit as I may claim for the original advancement of the suggestion—adopted by Dr. Hunt—as to the effect of variations of temperature and pressure in promoting alternate liquefaction and reconsolidation in a mass of mineral matter beneath the crust of the earth.

Dr. Hunt points my attention to a notice, by the Rev. O. Fisher, in the number of *Scientific Opinion* for October 27th last, which had escaped my observation. In it Mr. F. expresses a doubt as to the idea above referred to having been advanced in the *first* edition of my work on Volcanos (1825), he having searched through that volume without finding it. I beg, however, to refer him, or any one whom the point may interest, to p. 26 of that volume, headed "Effect of Increase of Temperature or Reduction of Pressure." Mr. Fisher will see, on reference to this and the following pages, that the passage quoted by Dr. Hunt (p. 60 supra), from the edition of 1862, only expresses, in more concise language, the idea here enunciated; which, indeed, forms the staple of my whole argument.

Dr. Hunt, however, differs from me in one important respect, believing that, under the supposed circumstances, the effect of increased pressure would be exactly the reverse of that which I suppose; pressure, in his view, promoting, not preventing, liquefaction, by "favouring the solution of the water-impregnated mass, solution being, with few exceptions, a process of contraction." I do not dispute the chemical theory on which this proposition is based, and, indeed, the partial solution of some of the mineral constituents of the subterranean matter (especially the silver) is involved in the idea of its igneo-aqueous fusion. But it is not inconsistent with this belief to suppose that the tendency to general liquefaction *in the mass*, possibly occasioned by such partial solution under increased, and the converse solidifying influence of diminished, pressure, may be more than counteracted by the opposite tendency of such portions of the super-heated interstitial water as exist at the time in the state of vapour, to contract in volume in the first, and to expand in the last case. It seems to me that all the phenomena of volcanic action are best explained by this hypothesis, rather than by the alternative which Dr. Hunt proposes. It is consistent with observation that as lava rises upwards in a volcanic vent, its effervescence—that is, its tendency to liquefaction and elastic expansion—increases with a diminution of pressure, even though so slight as that attested by a fall in the barometer, as is seen in the case of Stromboli. And it is difficult to believe that this process is reversed in the interior of the volcano. On this point I will say no more, but only refer to my paper in this Magazine, Vol. V., p. 537.

Before concluding, I ought, perhaps, to notice the challenge addressed to me by Mr. Fisher (p. 45 supra), who, attributing to me, with justice, the opinion that "the motive power in the elevation of mountain chains is the pressure from below of matter expanded by an accession of heat," opposes to this view what he calls the contrary one, viz., that the effect in question is produced by "the crumpling of the crust through lateral pressure caused by a general cooling of the globe; the elevation of portions of the crust, by this process, occasioning a diminution of pressure and consequent liquefaction in the subjacent mass." My reply is, firstly, that my view is built solely on recognized facts, such as the proved upward transmission of heat from below the earth's surface, and the undeniable inference from known laws of physics, that the rate of this transmission, in other words, the subterranean iso-thermal plane, must vary locally with those variations in the thickness and conducting powers of the sedimentary deposits on the surface, which we know to be always taking place, (p. 308, Volcanos). I have purposely abstained from theorizing upon any mere *assumption*, such as that from which Mr. Fisher deduces his view, viz., the secular cooling of the entire mass of the globe, and its "consequent contraction within a solidified crust"—an assumption which, in the present state of our knowledge, is not, I think, sufficiently justified to afford a reliable postulate in geological speculations, though I am quite aware of its popularity and plausibility. At the same time I may observe that this view of the primary cause of the elevation of mountains (which is that of Cordier, Elie de Beaumont, and many others) is not inconsistent with mine, viz., that the direction taken by the lines of fracture in the earth's crust, under the supposed circumstances, and consequently the positions of the alternate areas of elevation and depression, must be determined by the local conditions of comparative tension—that is, of temperature—in the matter beneath, and of the resistance in the crust above; the elevated areas consequently coinciding with those in which the expansive influence of subterranean heat predominates over the sum of resistances offered by the crust above; and the depressed areas to those in which these conditions are reversed. That intense heat was the chief agent in the upthrust of the crystalline axes of most mountain chains is proved, I think, by the signs they exhibit of having *melted their way into* the overlying rocks, which they at the same time appear to have upheaved. While the volcanic or trap rocks, on the contrary, seem to have risen through fissures with scarcely any disturbance or metamorphism of the sides of these. The former I consider the direct effect of subterranean expansion from increase of heat; the latter its secondary effect, due to the opening of lateral avenues of up-flow by the action of the first force. (See Volcanos, ed. 1862, p. 273.)

III.—On the Pleistocene Deposits of North Shropshire.

By Miss Charlotte Eyton.[1]

IN Professor Harkness's very interesting paper "On the Middle Pleistocene Deposits," he alludes to the beds described by Mr. George Maw, "in the valley of the Severn, between Bridgenorth and Shrewsbury, which seem to accord with the shell-bearing beds of Ireland."[2]

The Pleistocene deposits of Shropshire (of which I have attempted a brief description in my little work on the Geology of North Shropshire[3]) are of much greater extent and importance than the Severn valley beds (which, however, represent a very interesting portion of them). They cover a large part of the North Shropshire plain, both on the east and west, and are found both north and south of the Wrekin and the adjacent Carboniferous anticlinal. The lowest of these beds is a stiff blue clay, containing rounded, not striated pebbles, with Lias-fossils, which covers the country for some miles west of Shrewsbury. It lies upon the upper Bunter Sandstone, between the base of the Keuper beds, as seen at Pimhill and Harmerhill, and on the Severn. A section obtained by a well-sinking at Dunn's Heath, about three miles from Shrewsbury, gave a thickness of 104 feet before water was reached. Similar sinkings in different parts of its extent give about the same thickness, varying only by a few feet, though in one instance, at Leaton, a very short distance from Dunn's Heath, water was found at a much less depth.

The clay is visible on the surface at Leaton brickfield, the Old Woods, Fennymere, and Petton.[4] It is difficult to determine its exact boundary, as much of it is concealed by the overlying drifts, but it seems to extend westward up to the base of the small Keuper hills of Nesscliffe and the Clyffe, and then, following the low ground west of Grinshill and Hawkestone, to continue northward in the direction of Ellesmere, before reaching which it is thickly overlaid with drift. A portion of the clay near the Hayes Farm was found to be loaded with crystals of perfectly clear calcareous spar. The only shell which I have been able to obtain from this bed is a small but very perfect specimen of *Fusus antiquus*, from the Old Woods clay-pit, very different from the shattered remains of the overlying bed. Mr. Gwyn Jeffreys does not consider it a glacial form.[5]

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[1] It seems right to say that this paper was written before the publication of the article by Mr. Searles Wood, Jun., otherwise, perhaps, the opinion of Prof. Harkness might not have been adopted quite so implicitly, although it coincides with the idea I had previously conceived. The key to the problem in Shropshire lies in the position of the blue clay, and confirmatory evidence may be found in the many still undetermined fragments of shells which abound in the overlying beds. Next summer's work may add *Tellina obliqua* or *Nucula Cobboldiæ* to our fauna.—C. E., Jan., 1870.

[2] Geol. Mag., Dec., 1869, p. 546.

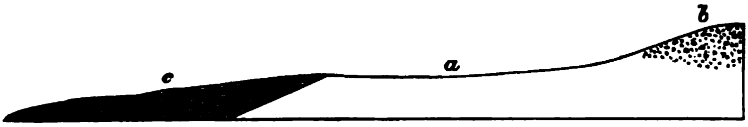
[3] Notes on the Geology of North Shropshire, chap. 6.

[4] The Geological Surveyors give a thickness of 120 feet to the drift near Petton.

[5] See a section given by Mr. G. Maw, south of Workington, Lancashire, where a lower blue clay is exposed, overlaid by reddish, silty clay. Geol. Mag., Vol. VI. Feb., 1869, p. 72.

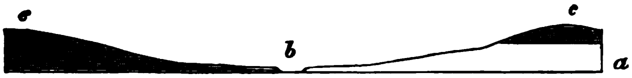
Lying upon this bed are mounds of drift, assuming the rounded contour described by Professor Harkness as "the outline of many of the deposits of 'manure gravel' in the county of Wexford," and also of Strethill.

One of these mounds occurs at Merrington Green, about six miles from Shrewsbury, and one mile from the base of Pimhill. It consists of very coarse unstratified gravel, rounded but not striated, containing Silurian and Carboniferous limestone fossils, mixed with a dark-coloured clay and with sand. I do not remember to have ever seen any flints in this bed. It contains abundance of shells in a very fragmentary condition.



Section 1. From Merrington Green to the river Perry, showing the relative positions of the older and re-assorted drifts.

a. Blue clay, Old Woods, etc.
b. Clayey gravel of Merrington Green.
c. Re-assorted gravel, Yeaton, etc.



Section 2. Showing the relation of the Werf stream to re-assorted gravels.

a. Bunter sandstone.
b. Channel of the Werf.
c. Re-assorted gravels.

The above are not drawn to scale, being merely intended to show the relative positions of the beds.

The species I have been able to determine are, *Tellina solidula, Astarte arctica, Cardium edule, Cardium echinatum* and columellas of *Fusus antiquus. Cyprina Islandica,* and *Turritella communis* or *terebra,* both so frequent in the beds near the Wrekin, seem to be entirely absent. On the whole it possesses, I think, sufficiently distinguishing characteristics to mark it as older than the gravels on the east of the plain, and than most of the middle drift deposits described by Professor Harkness. I do not know the altitude of this mound above the sea level, further than that it over-tops the spire of St. Mary's Church, Shrewsbury. A similar gravel may be seen in the ballast hole west of Baschurch station. Towards the north the mounds increase in number, forming in many places ridges, and, as has been previously stated, concealing the underlying clay, while the hollows are occupied by small meres and peat mosses.

At Leaton, three miles from Shrewsbury, there occurs another of these mounds, not quite so high as that of Merrington Green, and nearer the Severn. The material of this bed, however, differs so much from the preceding, consisting of finely stratified sand and gravel, with an entire absence of shells, that, notwithstanding the contour and the elevation at which it occurs, there seems no choice but to consider it provisionally as an Esker drift.

We now come to the shell-bearing gravels, which are so well developed in the Severn Valley and on the north and east of the Wrekin chain, and which appear to correspond, with considerable exactness, to the "manure gravels" of Wexford, and elsewhere in Ireland, and the marine drifts of Wales and Lancashire, on the western coast of Britain, and with those of Aberdeenshire, Caithness, and the middle sands and gravels of Norfolk on the eastern.

These gravels (I am speaking more especially of the beds on the north and east of the Wrekin, with which I am best acquainted; but I believe the same facts apply generally to the Severn Valley) contain a great variety of materials: Silurian, Carboniferous limestone and Lias fossils, granite, both pink and grey, coal and lignite, Permian sandstone and flints, enter into their composition.[1] The fragments are always rolled, except in the case of syenite and greenstone, brought from the neighbouring hills, which are generally angular. I do not think that any of the material is derived from the local Triassic beds. Boulders of granite and dark-grey Silurian limestone are common in association with these drifts, the latter sometimes veined with quartzite. The presence of these and of the rolled pebbles of granite and Lias surely indicate a current from the north, as the Lias must have been brought from the Cheshire border, and the granite from Cumberland. The Silurian and Carboniferous fossils may have been brought from Flintshire or Denbighshire, on the north-west; though it certainly seems more reasonable, at first sight, to consider them as derived from the neighbouring beds of South Shropshire, in which case it must have been a current, probably local, from that direction which bore them to their present position.

By far the richest locality in shells to be found in Shropshire is the Severn Valley drift, exposed between the Union and the Welsh bridge, above the quarry walk, Shrewsbury. Here is a large gravel-pit, where the beds are seen to be composed of stratified sand and gravel, layers of shell-sand occurring at intervals of two or three feet, loaded with comminuted fragments, and frequently containing perfect valves. The base is not seen. This deposit bears the strongest resemblance in character to the description of the Wexford manure gravels of any of the Shropshire drift-beds. The same gravel appears in the cutting of the Shrewsbury and Wellington Railway, and also of the Shrewsbury and Hereford Railway, south of the Severn; but I have never searched these localities for shells. A bed of similar character occurs in a ploughed field above Brian-hill turnpike, between Shrewsbury and Eaton Constantine; indeed the deposits seem continuous along the Severn Valley. The higher part of the town of Wellington is built upon a bed of dark-red clay, used for brickmaking, containing rounded pebbles of the usual materials, but no shells, it corresponds, probably, to the clayey gravel of Merrington-green. Against this, but not upon it, there rests a bed of rather coarse gravel mixed with sand. I have seen nilar but still coarser gravel resting upon fine sand, in a newly-ied gravel-pit belonging to W. Moyley, Esq., near Buildwas, in Severn Valley. There I only obtained a few fragments of *rina Islandica* and *Tellina solidula*, but the Wellington deposit, les these and other bivalves, is, notwithstanding the roughness of material, the best place I know of for small and delicate uni-es. It seems as if their minute size enabled them to lie more y concealed in the interstices of the gravel, and better to resist grinding process to which they have been subjected. This gravel ly seen in one place—on the right-hand side of the Haygate-road, ; of the town of Wellington. I have to thank Mr. D. Jones for ring my attention to it. About a mile and a half to the east of the a, extending for some distance on either side of Ketley Brook, there rs another bed of sand and gravel, resting upon clay, containing same materials, with a much larger proportion of sand, and most ie commoner species of shells belonging to these drifts. According to a level taken from the top of the Wrekin to the Severn at lport, Ketley Brook is 190 ft. above the latter with 6 ft. water; this, I think, will be very nearly the base of the range of ude at which the shell-bearing gravels are found, as the next-tioned bed will give an approximation to their greatest elevation hropshire above the present sea-level. This bed lies nearly five s to the north-east, at Lilleshall, in a field belonging to the New ge Farm. It assumes a mound-like, rounded contour, and rests nst the Permian sandstone. It contains, I believe, all the erials above enumerated. Mr. C. J. Woodward, Curator of the ningham Museum, has described this deposit, in a paper read re the British Association at Birmingham,[1] and I have to thank Henry Woodward for pointing out his communication to me, and for his kind assistance in naming some of my specimens. Mr. . Woodward states the summit of the mound to be 463 ft. above n sea-level.

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[1] It should be observed that although flints certainly occur sometimes in these beds, north-east of the Wrekin, they are by no means a marked feature. Of the transported rocks, grey granite is perhaps the most abundant.

lthough these beds are only visible in places, and sometimes ime locally the form of mounds, they are, in reality, portions of aces of which the intervening parts have either been denuded or concealed by overlying beds. The latter is the case at Orleton, than a mile to the west of the gravel-bed in Haygate-road, Wel-ton, where a bed of sand and gravel, containing shells, was cut ugh in making a drive, many years ago, and is now grown over. same bed was found at Hadley, lying between Ketley and eshall, where, in digging the foundation of the church in 1854, imens of *Turritella communis* and *Tellina solidula* were procured. y are, in fact, raised beaches, as well marked in all their chief racteristics as any recent beach; and in this they seem to differ ewhat from deposits of the same age in Wexford and Norfolk, the ter of which are described as "occupying an area forty miles in th by from eight to nine miles in breadth."[2]

Vith regard to the distribution of the shells found in these beds,

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[1] Brit. Assoc. Rep. 1866.

[2] Geol. Mag., Dec., 1869, p. 542.

Fusus antiquus appears to be characteristic of the whole series, from the Blue Clay upwards; *Tellina solidula, Astarte arctica, Cardium edule,* and *Cardium echinatum* range upwards, from the clayey gravel of Merrington-green. Not that there may not be some other species in a very fragmentary state in that bed, but the chief point to be noticed is the total absence of *Cyprina Islandica* and *Turritella communis*—both so characteristic of the sandy gravels—the coarse, strong fragments of the former of which could hardly escape attention; while the latter, from its shape, is peculiarly formed to resist destructive influences. In Norfolk, the range of *Tellina solidula* commences much lower down, at the base of the whole glacial series.[1] Mr. C. J. Woodward gives a list of twenty-two species of shells, from the sandy gravel of Lilleshall, of which two species—*Natica clausa* and *Scalaria communis*—have not been found, I believe, in any other locality in Shropshire. Of another species in his list—*Lutraria elliptica*—I have found some doubtful fragments near Ketley Brook. Mr. G. Maw, in the list appended to his paper,[2] enumerates thirty-nine species found by him in the Severn Valley beds, of which the greater number are also common in the other localities mentioned in this paper—or at least fragments of them, for perfect specimens are somewhat rare. To these I have to add the following, collected from the sandy gravels in the different localities above named:—*Astarte elliptica, Cardium Norvegicum, A. compressa, Nucula nucleus, Mactra subtruncata, Trophon clathratus, Lucina borealis* (?), *Mangelia rufa*—making 50 species from these beds at present known. The authority used is Messrs. Forbes and Hanley's work on British Mollusca.[3] Mr. C. J. Woodward mentions *Trophon Banfferius* (? *Bamffius*) among his collection, but the specimens of *Trophon* that I have found do not, I think, belong to that variety.

By placing these sands and gravels on the horizon of the Middle Drift, another point is decided, namely, the age of the Boulder-clay on the Welsh coast. Although this formation does not extend so far south as Moel Tryfaen, it is very well exhibited in the neighbourhood of Abergele, as a dark-red clay, containing numerous subangular and striated blocks of limestone and other rocks.[4] Near the village of Colwyn, west of Penmaen Rhos mountain, there is exhibited a section where the clay has been removed, and the middle sands and gravels deposited in its place. I do not remember any locality where the actual contact is seen, but there can be no doubt, to any one who carefully examines the relative position of the beds, that such is the case. As in the section described at Howth,[5] the Boulder-clay rests immediately upon the Carboniferous Limestone. This position definitively decides it to be the early, not the later, Boulder-clay.

At a range of altitude, the higher elevations of which correspond with the lower parts of the marine terraces, while the base is situated, generally speaking, about 20 ft. above the present stream and river system, there is another series of drifts, so closely resembling the former, that in some situations it is difficult to avoid confusing them, as they contain all the materials of the older drift, and often assume the same rounded contour. The principal distinguishing characteristics are, 1st: The presence of quartzite pebbles from the Triassic conglomerate, generally in considerable numbers. 2ndly. The entire absence of any trace of shells. These drifts are principally composed of the re-assorted and degraded materials of the marine beds, so thoroughly "washed and sifted" as to destroy all organic remains, with the addition of the round quartzite pebbles, pink, white, and yellow. They correspond in many particulars to Mr. Kinahan's "Esker Drift,"[1] but they differ in one respect—the presence of a large number of flints in some of the beds. Boulders of grey granite sometimes occur in connection with them. They do not occur generally in terraces, but are spread out over most of the flat country, though they sometimes form mounds and banks on the sides of river valleys. They are, I think, the remains of an older and more powerful stream and river system than that now in existence, aided, probably, by extensive floods, occasioned by melting snows, and possibly by the action of land ice.[2] Had they been arranged by marine currents, we could hardly fail to find some traces of marine organisms, considering how abundant these are in the older drift, and how invariably they fringe the courses of such currents, tidal or otherwise, in the present sea.

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[1] Geol. Mag., Oct., 1868, p. 452. [2] Quart. Journ. Geol. Soc., 1864.

[3] These shells are all drifted specimens, washed up by the waves, in a dead state with the sand and shingle of the beach. They are most frequent where the deposit i bedded, and both valves are never found joined.

[4] See "Drift-beds of Llandrillo-bay," Geol. Mag., August, 1868.

[5] Geol. Mag., Dec., 1869.

The Werf, a small tributary of the Severn, flowing from a few miles east of Shifnal, through Ryton and Beckbury to Bridgenorth, cuts its way through high banks and mounds of drift, assuming all the outward contour of marine terraces, but composed principally of materials from the neighbouring Trias, and—at least between Cosford and Beckbury—without shells.[3] The beds occur on both sides of the valley, from 50 to 100 ft. above the stream; and one of the most striking facts connected with them is the way in which the stream cuts into them, forming its own bed of mud and silt—not gravel. Some of the mounds between Ryton and Beckbury lie endways to the stream.

On the banks of the river Tern, near Crudgington, there occurs a gravel bed, containing numerous flints, crushed and chipped, having evidently been exposed to some grinding process.

In the neighbourhood of Merrington Green the re-assorted drifts are found occupying the valley of the Perry, where they likewise contain flints, and also lying upon hill-sides, and occupying many positions to which no stream now in existence could possibly have borne them. Those deposits near the Perry are easily distinguished from the older gravel by being bedded. In one place, near Yeaton, they are blackened by an impregnation of lignite. I have already mentioned the doubtful example at Leaton.

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[1] GEOL. MAG., Dec., 1869, p. 569.

[2] See Rev. O. Fisher's "Denudations of Norfolk," GEOL. MAG., Dec., 1868.

[3] Marine drifts do occur, I am told, on the banks of this stream, nearer to Bridgenorth.

Occasionally, but very rarely, mammalian remains occur in these beds. I am indebted to Mr. Blunt, of Shrewsbury, for two teeth of an ox, found in gravel in the Abbey Foregate, Shrewsbury, and a horse's tooth, perfectly blackened with age, was found in sand in digging the foundation of a bridge between the villages of Bratton and Eyton, near Wellington.

There appear to have been two distinct periods of denudation in Shropshire during the formation of this whole series of beds. First, the denudation of the Lias; and secondly, that of the Triassic conglomerate. The former of these must have been effected by a current from the north, bearing with it northern materials, granite, etc. Indeed, its course across the plain of Cheshire seems well marked by the clays, sands, and gravels which it deposited. Crossing the Lias, of which the remains still exist on the Shropshire and Cheshire border, overlying the Keuper Marls, it proceeded southward across the plain of North Shropshire, leaving its traces in the deposits, from the Blue Clay, upwards, to the sandy gravels, behind it.

The Silurian ridges of South Shropshire seem to have acted as a check to its progress, which was diverted to the south-east, whence it proceeded down "the ancient Straits of Malvern" (weakened, however, in force, and bearing a very diminished number of recognizable species of shells) into the Irish Sea. This, at least, was Sir Roderick Murchison's opinion, and there scarcely seems sufficient reason, in any of the modern discoveries, much as they have increased our general knowledge of these beds, to weaken its force. While, therefore, we thankfully accept a position for our ancient sea-beaches on the horizon of the Middle Drift, we cannot yet give up our right to their old title, bestowed upon them by the father of Shropshire Geology, that of "Northern Drift."

The denudation of the Triassic conglomerate took place, as we have seen, at a later period and under different auspices. The reasons which render it doubtful whether this could have been the effect of marine agency, have been already stated, while on the other hand the very large amount of material removed (for this bed, like the Lias, remains a mere wreck of what it has been), and its even distribution over the plain, show it to have been the work of far more powerful and widely-spread forces than any now in action; and again, as the materials of these re-assorted drifts are all derived from local sources, the presumption is that they owe their origin to local agents.

Between these two periods, one apparently of general, the other of local denudation, there was an interval of which we have in Shropshire no traces—that of the later Boulder-Clay. I am not aware of any instance in which the marine drift is overlain by clay, nor have we any beds in any part of North Shropshire that can be assigned to this formation. It is difficult, sometimes it seems well nigh impossible, to correlate any series of beds with those corresponding to them in another series, known only by description, however lucid and exact such descriptions may be. The idea throughout this paper has been to place the Pleistocene deposits of Shropshire, especially those underlying the Middle Drift, to which Professor Harkness has satisfactorily assigned its true position, on horizons corresponding to some of the beds on the eastern coast; but, aware of the very unsatisfactory nature of the evidence afforded by the few species of shells found in our lower clays and gravels, I have refrained from applying to them any of the terms by which Messrs. Harmer and Searles Wood have designated their lower glacial deposits, which might prove to be entire misnomers. I should be most grateful for lists of species found in glacial deposits in any locality, and would gladly exchange specimens from our middle drifts for shells from those beds. Collecting these specimens, and making lists of them, is a work peculiarly suited to lady geologists, on account of the small amount of manual labour involved, and the quickness of eye and delicacy of touch demanded.

EYTON, NEAR WELLINGTON, SALOP, 1869.

IV.—ON THE SITUATION OF THE IRON-ORE FOSSILS IN THE WATER BLAIN MINES, SOUTH CUMBERLAND.

By MISS E. HODGSON.

AT a meeting of the Literary and Philosophical Society of Manchester, December, 1867, a paper was read by Mr. E. W. Binney, "On the Age of the Hæmatite Iron Deposits of Furness," when he exhibited and described some iron-ore fossils brought by me from the Water Blain mines, west of the Duddon.

Without pretending to the knowledge of Fossil Botany that enabled Mr. Binney to refer these, without hesitation, to *Lepidodendron* and *Stigmaria*, I would, on introducing the subject of their situation, or mode of occurrence, say that the frequent careful investigations made, on every opportunity afforded me by visiting in the neighbourhood, together with the daily study for a time of a good selection of specimens, have tended to confirm a belief in their vegetable origin, and to train the eye, as it were, into a recognition of ligniform structure, which, on account of their highly mineralized state, is liable (except by those well practised in the science) to be either overlooked or misinterpreted.

The excavations for iron ore at Water Blain are on the band of Coniston Limestone to the east of Millom Park. The geology of the tract is noticed by Professor Sedgwick. After describing a series of faults which dislocated the entire region—"tore the whole system of Millom Park bodily from the other rocks of the same age, and carried them full two miles to the south-east of their original strike" (the succeeding Coniston Limestone group likewise), he says:—"From the marshes south-east of Wander-hill[1] to the pastures south-west of Beck Farm, a distance of full two miles, the Coniston Limestone group is magnificently developed."

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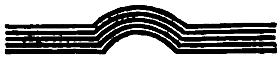
[1] Wander-hill, of the old Cumberland Maps—Under-hill of the Ordnance Surv

It is within this "distance of two miles" that Water Blain is situated. Again:—"At Water Blain the limestone is cut through by a fault, marked by a narrow marshy valley, beyond which the limestone is contorted, and traversed by thick veins of red oxide of iron." Mention is also made of the limestone being "partially altered, and penetrated by flakes of serpentine." See a paper by Prof. Sedgwick, "On the Classification of the Fossiliferous Slates of Cumberland, Westmoreland, and Lancashire," read before the Geol. Soc. London, 1846.

The following particulars relating to the fossils, kindly furnished by Mr. Ezekiel Dawson, manager of the mines, have now been more than a year in my possession, and I am unwilling they should any longer remain unpublished, as I think they may render the subject more intelligible to the minds of those who have demurred at the announcement of fossil trees being found in the older rocks. They were communicated, partly in conversation and partly by correspondence, and they are, I believe, faithful records of the facts.

It was in the early part of the year 1866 that this interesting discovery was made. A large fossiliferous mass, or tree-trunk, was met with standing erect in a cleft or cavity of the limestone, resting upon, and surmounted by, horizontal beds of what Mr. Binney calls ironstone. The depth of the cleft from the surface was about 20 ft., having a capping, over the mineral, of drift—the Boulder-clay of the country. The width of the cleft might be 50 ft. by 36 ft.

The fossil, as near as could be remembered, had stood from 12 to 15 ft. high; its diameter, at base, being from 20 in. to 2 ft. It was branchless, and without any observable ramifying roots—"very like" (Mr. Dawson said, on its being shown to him) "the figure given by Mantell, from Lindley and Hutton, of *Sigillaria pachyderma*"—Wonders of Geology, sixth edition, vol. ii. p. 719, Lign. 161—"the top of the fossil making the beds of ore overlying it assume a convex form, thus":—



From a sketch by Mr. E. Dawson.

while they were also observed to have sloped up towards it, on all sides, at a gentle angle from a distance of two or three feet throughout its depth. As the miners came upon the tree at two levels, I was anxious to learn whether any bark-markings had presented themselves; but while it was admitted that, roughly, there might have been some resemblance to certain bark structures, yet it must mainly be described as having had "a coarse sparry crust, with vertical 'pipes' running through it." The miner's language is capable, no doubt, of translation by the botanist.

A block from this trunk, identified as such by Mr. Dawson, with two smaller specimens of the same, selected by himself, and handed to me with the remark that they were "very like wood," are now in the possession of Mr. Binney.

But the above tree-like form was not the whole of the discovery. Imbedded likewise in the ironstone, and occurring for the most part near the walls of the place, and low down, were numerous twig-(?) like remains. These are of a harder nature than the trunk mass—they are in better preservation—and in some specimens exhibit beautiful minute striation, with what seem to me to be little scars arranged in a uniform pattern. They are well worth collecting, are not very scarce, and the miner's hammer will bring out good examples.

The cleft, whence all that was of interest has long been removed, is now partially filled with mining refuse and rock debris. In the eastern end of it a shaft was sunk upwards of forty feet further, passing through decomposed limestone containing one bed of ore. From the shaft, adits have been driven beneath the floor into sound limestone generally, with here and there decomposed portions tinged with the mineral. The marketable product, associated with the fossils, was the soft red oxide, found in layers of from one to seven or eight inches thick between the hard beds of ironstone, several hundred tons of which had been gained. Lamination is sometimes finely shown in blocks from the hard beds, and cleavage-planes, at right angles to the bedding, set with glittering crystals of iron-stained quartz.

Narrow fissures in the limestones near, open to the drift, have revealed other curious forms of hæmatite, but whether they also are of vegetable origin, I am unable to say. Their chief peculiarity is a kind of foliation, ascribed by some observers to heat, but which I would suppose might be the result of great pressure: they are unlike any varieties I have ever seen in Furness.[1]

V.—On Faults in Strata.

By W. T. Blanford, A.R.S.M., F.G.S.

My friend and colleague, Mr. H. B. Medlicott, published, in the August (1869) number of the Geological Magazine, a paper "On Faults in Strata," in which he endeavoured to show that the evidence usually accepted for faults, in the true geological acceptation of the term, is insufficient; that a large number of the lines of junction between rocks of dissimilar age, usually mapped by the Survey of Great Britain and other Surveys as "faults," are, in truth, natural junctions, due to deposition against cliffs or other steep surfaces; and that direct evidence of friction is necessary to establish the existence of a fault. The latter is rather left to be inferred than positively asserted; nevertheless it is very clearly intimated that it is the writer's opinion.

I have expected in vain that some member of the Geological Survey of Great Britain would have defended the system of mapping adopted in that Survey, but hitherto no one has replied to Mr.

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[1] Two articles on the subject appeared in *The Grange Visitor*—a weekly newspaper for 1868, D. Atkinson, printer, Ulverstone—by Mr. J. P. Morris and Mr. Samuel Salt.

Medlicott's remarks. The subject is one of very great interest and importance, indeed it may be said to be a fundamental question in Geological Surveying; and, as I differ in opinion from Mr. Medlicott, I wish to offer a few remarks in defence of the faults.

The first point upon which I should join issue with Mr. Medlicott is his demand for direct evidence of friction surfaces or *slickensides*. I have not myself noticed these, as a rule, in undoubted faults—I mean faults exposed in cliff or mine-sections, in which the beds are distinctly seen at different horizons at the opposite sides of the fault—and I believe that my experience in this respect will be corroborated by most field-surveyors. Mr. Medlicott refers to the parallel case of glacial action, but to this I object entirely, for two reasons:—

1st. The circumstances under which friction-surfaces produced by glaciers become visible involve the partial or total disappearance of the glacier—a process not necessarily attended by any important weathering of the rock-surfaces against which the glacier impinged; but the removal by denudation of a large portion of the rock from one side of a fault, without any weathering of the opposite surface, is almost an impossibility. In ninety-nine cases out of a hundred, the rocks on both sides of a fault weather evenly, or nearly so; the harder rock rising from the line of fault gradually. In order to find the parallel to this, the rock bounding a glacier should be removed *pari passu* with the glacier itself, no bergschrund or fissure intervening. Under these circumstances it would be rather a difficult matter to find *roches moutonnés*, or grooved and polished surfaces.

2nd. The polished and grooved surfaces, which prove the former existence of glaciers, are invariably on the hardest and least easily weathered rocks, and are, geologically, of recent origin. No one supposes that any such evidence could now be found, even of Pliocene glaciers; but faults are of all ages, the vast majority being Pre-tertiary at least. Again, every field geologist, who has worked in countries where granitic and other crystalline rocks occur, must have noticed the remarkable manner in which smooth surfaces, freely exposed, resist weathering. Blocks of granite may often be seen, the upper exposed surfaces of which are fresh and unaltered, whilst the sides and lower surfaces, which have been in contact with turf soil or other masses of rock, are much disintegrated. The former, free exposure, is the condition of the glacier-worn surfaces, most of which are on crystalline rocks; they have never been exposed to any more destructive influence than that of pure water in the shape of rain: the latter, that of contact with other rocks, is the condition of the polished or grooved surfaces in a fault. Moreover, a fault is usually more or less a plane of percolation for waters, often, if not invariably, charged to a certain extent with gases and salts in solution, and thus capable of effecting a chemical change in the rocks percolated, which will certainly destroy friction-surfaces; and these destroying influences have, in the vast majority of faults, been at work, not since the glacial epoch merely, but through the countless ages of geological time which have elapsed since the Mezozoic or even the Palæozoic formations were consolidated.

For these reasons I believe that friction-surfaces in faults rarely exist, and can still more rarely be seen; and I believe a false principle will be introduced into geological surveying if their existence be demanded as the only *direct* proof of faulting.

The next point upon which I differ from my friend is the confusion which, in his opinion, exists between lines of fault and abrupt boundaries caused by deposition against steep surfaces of older rocks. In my opinion these can but rarely be mistaken for each other, and for this reason;—

Scarps and cliffs, throughout the world, rarely, if ever, are either straight or composed of a series of straight lines. Almost invariably they are much curved, indented, and cut back every here and there by valleys. Now the essential character of a fault is that its direction approaches a straight line, or is formed of a number of straight lines meeting each other at angles, usually open or obtuse, rarely or never in deep curves. The straightness of a line of boundary is, I think, by most geologists considered far more important evidence of faulting than friction surfaces; and it has the enormous advantage of being more easily demonstrated. Now this most important point is entirely omitted by Mr. Medlicott, who does not even refer to it; and yet it is by this character that the great abrupt lines of boundary, which are so remarkable a feature in certain Indian deposits, and which almost invariably limit the principal Indian coal-fields, on one side at least, have been by myself and several of my fellow-surveyors attributed to faulting—a view which Mr. Medlicott disputes. Unless I am greatly mistaken, this character is also considered essential by Professor Ramsay and the officers of the Geological Survey of Great Britain.

Unquestionably Mr. Medlicott's warning against carelessness in assuming all abrupt boundaries to be faults, merely because there is evidence of crushing, is just; and I believe that many instances have occurred, where the boundaries in question are obscure, and their length and the apparent throw inconsiderable, in which mistakes have been made; but these mistakes will, I believe, usually be found to be of small practical or scientific importance. It is not at all my intention to enter into the question of the great lines of abrupt boundary on the flanks of the Alps and Himalayas. Mr. Medlicott's evidence is, in the latter case, for a portion at least of the boundaries, incontestable. But I object to his illustration from the Garo hills. Because he in one spot found a natural boundary, it does not seem to me a logical inference that there is no fault at all. He admits there has been great and abrupt "relative movement." It should not be forgotten that observations at the base of the Garo hills are made in pathless jungle-forest, of a kind of which European geologists can have but a faint conception—where an elephant may be standing within two yards, and yet be utterly invisible—in the densest of underwood beneath thick high trees, where, as a rule, rocks are only to be seen in stream sections. In such ground, especially, the presence or absence of a "master-fault" would, to my mind, be entirely dependent on the form of the boundary, straight or curved; and if the

boundary were straight, I should conclude that the discovery of suc a natural junction as that described by Mr. Medlicott proved, not th absence of a fault, but simply that in that spot the newer rocks ha been denuded away from the neighbourhood of the fault, and th natural boundary exposed. I do not mean for an instant to asser that this is the case at the foot of the Garo hills; all I contend is that the evidence offered does not, to my mind, disprove the existenc of a fault.

Chanda, Central Provinces of India, Jan. 3rd, 1870.

VI.—On Faults in Strata.

By G. H. Kinahan, M.R.I.A., F.R.G.S.I., &c.

THE acute observation of the late Professor J. Beete Jukes, combine with his power of reasoning from Nature, and by Nature's laws enabled him at once to be capable of explaining the relations o complicated strata, over which others might puzzle for months neither was he unwilling to impart his knowledge to others, fo nothing seemed to give him greater pleasure than teaching an explaining away difficulties, by pointing out the similarity betwee the former and present agents at work fashioning the surface of ou earth.

In Mr. Medlicott's paper "On Faults in Strata,"[1] similar argument to many of those of this eminent geologist, against the indiscriminat use of faults, are given. Moreover, Mr. Jukes often impressed o his assistants that which is here so well put forward by Mr. Medlicot —"The result may look very well, but it will leave us no wiser a to the natural history of the rocks."

At the present day, the marginal rocks of groups, now in th course of formation, are as often being deposited at the base of, o against, a cliff as elsewhere; and if now, why in the ages long pas should not similarly placed rock have been formed? That the should exist seems probable, and the following instances in Ireland worked out under the superintendence and with the able assistanc of Mr. Jukes, may be mentioned. In the county of Limerick, lime stone and other rocks of the Carboniferous age are deposited agains masses of contemporaneous Igneous rocks.[2] In Slieve Bloom, th mountains at the border of the Kings Co., in the hills southward o Nenagh, Co. Tipperary, in Slieve Aughta, the mountains at the junctio of Clare and Galway., &c, &c., the basal sandstones and conglomerate of the Carboniferous period [or the Old Red Sandstone] were deposited against cliffs of Lower Silurian rock[3]; while in the promontor of Dingle, Co. Kerry, the basal bed ["the Inch conglomerate"] o "the Dingle beds" is deposited against and at the base of ancien cliffs of Silurian rocks[4]; and in the country adjoining the north part of Lough Corrib, Co. Galway, there are Silurian rocks deposited against cliffs of Metamorphic rocks.[1]

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[1] Geol. Mag., Vol. VI., p. 341, August, 1869.

[2] Memoirs of the Geological Survey, Maps and Explanations of Sheets 143, 144, 153, and 154.

[3] *Ibid*, Maps and Explanations of Sheets 118, 124, 125, 126, 127, 134, 135.

[4] *Ibid*, Maps and Explanations of Sheets 160, 161, 171, 172.

In the places enumerated there are good data for the mapping of faults, if the relative dips and strikes were alone considered: however, in none of the places mentioned are the normal positions of the groups or varieties of rocks changed by faults or dislocations. In the King's Co., Tipperary, Clare, Galway, and Kerry, wherever a section near the base of the cliffs is exposed, the old shore-conglomerate occurs, over which the other rocks were deposited. These younger rocks—irrespectively of those with which they are in juxtaposition—sometimes dip away from the cliffs: in other places they are horizontal, while often they dip towards them. The last-named position would be quoted, by some geologists, as evidence of a fault; however, no dislocation is necessary, for if the younger strata, after deposition, were twisted or contorted, parts of them would almost certainly have been so disturbed that they would now dip towards the cliffs, while originally they were deposited horizontally, or dipping away from the cliffs. In the Co. Limerick faults might be also inserted, as in places the "Derivate-rocks"[2] occur, striking up against the "Ingenite rocks;"[3] but if the country is properly examined, it will be found that higher beds are continuous over both classes, proving that the "Derivate-rocks," which strike against the Igneous-rocks, were deposited in hollows, or against cliffs.

Although friction-surfaces generally occur in the fault-lines, if it is a simple fault, or on the two walls, if the line of break is marked by a dyke of "Fault-rock"[4] yet in some instances none can be observed, all traces having been obliterated by a subsequent action. If rocks, after being faulted, are metamorphosed, the Fault-rock may be cemented to the adjoining rocks, and thereby make a compact mass, which will be easier broken anywhere than along the original walls of the dyke or vein of Fault-rock. As such cases seem to be the only exceptions to the rule as laid down by Mr. Medlicott, they appear to add weight to it; moreover, even in them the obliteration of the friction-surfaces is not universal; for if the original Fault-rock were *flookan*, or any flaky stuff, the subsequent metamorphic action would be almost sure to have altered it into a schistose rock, with a foliation parallel, or nearly so, to the walls of the dyke, and thereby not disturbing the features of the original walls, except, perhaps, by modifying the termination of the planes of foliation in the adjoining rocks.

VII.—The Water-Bearing Strata in the Neighbourhood of Norwich.

By John E. Taylor, F.G.S., etc., and A. W. Morant, F.G.S., etc.

The extensive excavations for sewerage purposes, which have been going on for nearly two years, have brought to light several peculiarities in the relative water-bearing properties of the various strata in the neighbourhood of Norwich.

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[1] Geological Map of Ireland, Sheet 95.

[2] Sedimentary rock ?—Edit.

[3] Igneous rocks ?—Edit.

[4] The rock made up of the debris of the rocks through which the fault passes.

It is thirty years ago since Sir Charles Lyell propounded a theory which should explain the occurrence of sand-pipes, or "sand galls," as they are termed in Norfolk, in the Chalk strata. It is scarcely necessary to mention that this was based on the power of percolating water, slightly charged with acid, to dissolve and remove masses of calcareous material. Although this theory was combated by the late Mr. Stark, of Norwich, who endeavoured to explain the origin of sand-pipes in the chalk by referring them to fissures or crevices which had been subsequently widened, the explanation just referred to, backed as it afterwards was by the researches of Mr. Prestwich, gradually passed into common acceptance. Lately there has been a disposition, on the part of several geologists, to ascribe many of these sand-pipes to the mechanical action of miniature whirlpools triturating the bottom by the grinding power of gravel and coarse sand. We doubt not that in some of the harder rocks small hollows may thus be formed, but we are convinced that no other theory than that of chemical action will account for the large and small sand-pipes in calcareous strata. In the neighbourhood of Norwich, where the Upper Boulder-clay contains large quantities of chalky rubble, small sand-pipes are common, showing that the water has dissolved as much as it possibly could of the calcareous material. The thickly bedded Norwich Crag is frequently dissolved away in a similar manner, and this phenomenon is still more common in the Red and Coralline Crag districts.

We regard these sand-pipes as so many natural drains. The recent classifications which have been made in Norfolk geology, however, bear a distinct relation to the mode in which sand-pipes occur. In the first place, wherever we have the *disturbed* or "glaciated" Chalk, these pipes are usually present in the greatest number. On the contrary, where the hard undisturbed Chalk comes up, sand-pipes are of rarer occurrence. The recent drainage excavations prove that water percolates very slowly, and with great difficulty, through the re-deposited Chalk. This gives the diluted acid more time to operate, and as the Chalk is very much comminuted, the liquid is better able to act upon it, owing to the number of surfaces thus presented. In the hard or undisturbed chalk the water sooner disappears, although in larger quantities, through the various joints and fissures, and along the horizontal beds of flint, until it reaches the level of saturation.

It is the re-deposited Chalk, or "Chalk-marl," as it is called in the vernacular, which is distinguished in the neighbourhood of Norwich by numerous sand-pipes. In some instances the percolating water has carried down into the marl minute portions of oxide of iron, which have more or less coloured the stratum, and cemented it more firmly together. The area of this re-deposited Chalk, and the number of sand-pipes found in it, are more or less governed by the nature of the overlying strata. As might be expected, they are most numerous where these consist of alternate layers of sand and gravel. The surface-water readily finds its way through these, and instantly acts upon the Chalk. Sometimes the lower stratum of gravel is very much consolidated and extremely hard, owing to the water having carried down portions of oxide of iron from the upper to the lower parts, which it has thus cemented together. When the re-deposited Chalk is overlain by beds of clay or brick-earth, sand-pipes are rarer in occurrence, and smaller in size. The rarity is due to the difficulty of percolation, and the small size to the slight percentage of acid having already combined with, and dissolved, the calcareous matter mixed with the brick-earths or clays. The tortuous or winding sand-pipes usually occur where the overlying strata overlap each other's edges, so that the action of the water has been guided by its line of drainage.

The pebble beds of the Lower Drift are largely developed in the neighbourhood of Norwich, and where these overlie the re-deposited Chalk, sand-pipes are very common. We have remarked on the cementing power of the percolating water, and several instances are on record where hollows occur in these gravels, just above the sand-pipes, as at Horstead, Brandon, etc. In every case these hollows, or natural caverns, have been caused by the falling of portions of the overlying gravels into the hollow pipes dissolved out of the chalk. This circumstance utterly precludes the possibility of sand-pipes having been eroded by mechanical action. As has already been remarked by Sir Charles Lyell and Mr. Prestwich, in every case the sand-pipes are filled up by material falling in from above, or carried there by the water in its process of dissolution. The age of these sand-pipes, or rather of their filling-up, can sometimes be told. For instance, last May there was exposed in a marl-pit at Coltishall, about six miles from Norwich, a fine sand-pipe, running down the face of the section, and having a diameter of nearly forty feet. The pebble beds overlie the chalk, and we could plainly see where the whole of the strata overlying the pipe had been let bodily down to a depth of above twenty feet from their original position. Notwithstanding this, the contour of the surface was not affected in the slightest degree, so that this sand-pipe must have been formed, and the pebble beds let into it, before the existing configuration of the surface was produced. During the progress of the sewerage works, several pumping-engines have been working night and day, lifting about 17,000,000 gallons of water in each twenty-four hours. The wells for two miles round Norwich have mostly been drained, although the river, which flows through the middle of the drained area, has been unaffected. The wells sunk in the solid undisturbed Chalk, were those first affected; the wells situated in the re-deposited Chalk, or "chalk-marl," being so in a less degree. Wells on the higher grounds, sunk through the sand and gravel, have been untouched, especially if they had a bottom of brick-earth. In practical well sinking it has been found necessary to bore through the re-deposited Chalk until the underlying hard chalk, into which it gradually passes, was reached, when water is found in abundance. The thickness of this marl varies from ten to thirty or forty feet.

The most important point in the sewerage works, as bearing indirectly upon the excavation of the proposed Channel Tunnel, is the fact that the chief difficulties met with in engineering operations occurred beneath the river level. Here the chalk and marl are thoroughly saturated, and, at only twenty feet below the level of the water in the river, it was found necessary to close-timber the top and sides of the tunnel before the brickwork could be put in, on account of its giving way by the pressure of water. The springs under the head of only twenty feet also boiled up with great force. On the contrary, above the water level, drift-ways were driven hundreds of feet in length, and left for months together, without any timber shoring being required. It requires little imagination to perceive how great will be the pressure of water, and how immense the difficulties arising from it, in the proposed Channel Tunnel, excavated beneath twenty or thirty fathoms of water, and through a bed of hard chalk, doubtless abounding in joints and fissures. It has been the low level, twenty feet beneath that of the river, which has created the chief engineering difficulty and expense attending the sewerage works at Norwich.

VIII.—THE MILLSTONE GRIT OF THE NORTH-WALES BORDER.

By D. C. DAVIES, Oswestry.

(*Concluded from the February Number, p.* 73.[1])

The total thickness of Millstone Grit in North Wales does not quite reach 300ft. This thickness is, I am aware, considerably below that given by several authors, who notice this formation incidentally; but I am prepared to say, from actual and computed measurement, made on the spot, that the above figures are substantially correct. The Carboniferous system, from the base of the Mountain Limestone to that of the Coal Measures in North Wales, is but an epitome of the same beds in the North of England, the middle member, the grits and sandstones, being thin in proportion.

From whence were the materials for these beds derived? This is a difficult question to answer, and my reply must be taken rather as a suggestion than as the solution of the problem. We must at once pass over the limestone, because, from the absence of fragments of it in the Grits, as well as from the fact that it is now itself partially covered by them, we must suppose that it was entirely submerged at the time of the deposition of the latter; partly for the same reasons we must, I think, pass over, for the most part, the closely adjacent Silurian beds, although in these we should find all the materials required. Quartz-veins for pebbles, felspar for cement, iron and manganese for colour, and sand in abundance. These materials we shall, however, find in greater abundance in the Cambrian and other older rocks that make up now the western promontories of Wales, some lying engulfed in Cardigan Bay, and which once, in all probability, stretched almost indefinitely towards that fabled Atlantis of the west which, to the geologist however, is something more than a poet's dream.

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[1] The "Pockets" (Figs. 4-7, p. 71) occur in one unbroken bed of sandstone, as stated in the text, not in jointed and bedded rock, as represented in the woodcuts.

But assuming that these Grit beds owe their origin to the destruction of old western lands, it will be seen that a considerable amount of sorting of the materials (both mechanically and chemically) would be required before these Sandstone beds could be deposited so comparatively free from extraneous matter as we now find them. The whole mass must have been sifted and re-arranged according to its gravity, bulk, chemical affinities, depth of water, etc. That these conditions have often changed on the same spot, is shown by the frequent alternation of beds of clay, shale, and sandstone. Great quantities of the lighter felspathic mud would be carried further out to sea, and may, probably, now exist as fine sedimentary deposits beneath the Coal Measures of the Shropshire and Cheshire plains. Is it out of place to imagine that in these lie buried the Encrinite heads, whose stems alone remain in the Sandstone beds of the Millstone Grit?

Fossils of the Millstone Grit of the North Wales Border.—Judging from its appearance elsewhere geologists have generally considered the Millstone Grit devoid of fossils; a sandy Lybian desert by the side of the teeming life of the limestone rocks. Thus, in an interesting book, written by the late Mr. George Roberts, of Kidderminster, it is stated, "Bands of drifted plants in layers distinct from the rock are found in its Upper Measures, with this exception—the Millstone Grit is void of fossils, and has only to be studied for its mineral character." Very recently the Rev. Charles Kingsley has reiterated this statement in one of his papers, in "Good Words for the Young."

In the year 1860, however, I communicated a paper to the Oswestry Field Club, announcing that the sandstone beds of this formation had been redeemed from this charge of barrenness, and some years afterwards, Mr. Prosser published an account, in the GEOLOGICAL MAGAZINE, of the fossils they had yielded to his researches.[1] The principal fossils are enumerated with the Sweeney section, and it will not be necessary to recapitulate them here, except to say that further north, in "Allinson's quarry," south of the Oswestry Racecourse, and in the "Forest Quarry," north-west of the same place, to the fossils in the upper beds may be added, *Spirifera bisulcata*, *Bellerophon*, a small *Strephodes*, *Streptorhynchus crenistria*, in several varieties, fragments of Trilobites, and an abundance of an uncertain species of *Athyris*, that continues to be plentiful northwards by Selattyn Tower.

In addition to the ever-present *Productus semireticulatus*, there are, in the top cherty beds of Allinson's quarry, *P. undatus* (var. *elegans*), *P. costatus*, and *P. Youngianus*.

The fossils are found in nests or colonies, in spots which we may suppose, from the unbroken appearance of their shells, were favourable habitats for the fauna of the period.

The most abundant fossil is *Productus semireticulatus*, var. *Martini*, which is to be found by hundreds within a yard of the topmost beds in the Sweeney section, and is found also in the red and yellow beds at its base, and downwards to the base of the Carboniferous Limestone, thus affording a good illustration of a species surviving during an immense period, amid widely diverse circumstances, and changes in the condition of the sea-bed. Among these shells at Sweeney are found fragments of *Orthoceratites* (see Mr. Prosser's paper, already referred to). One tolerably perfect specimen, measured 6ft. long by 1ft. 3in. across its mouth. Some idea may be formed of the abundance of smaller life in the seas of those days by considering what havoc must have been made by a creature like this. I call attention to this fossil for another reason. Treflach, a place close by, is a locality distinguished for the great size of the *Cephalopoda* in the Mountain Limestone. Both *Nautili* and *Orthoceratites* will, for size, probably surpass those from any other place in England. So that we have a small area which was inhabited by huge Cephalopods during a period necessary for the deposition of strata 350 feet in thickness, and we may infer, from the continued size of the individuals to the close of the deposit at this spot, that there was no lack of food for the family during the whole of that time. There is however a marked absence of fossils from the middle beds. This absence arises no doubt from the fact that the favourite resorts[1] of the organisms have not been touched by the quarryman. I have, however, numerous fossils found in fragments obtained from the neighbouring drift, which have evidently come from these middle beds. From one of these have been derived numerous specimens of *Schizodus*, which appear here for the first time, being better known in the later Permian beds. Mr. Davidson informs me that the *Athyris* I have before mentioned as occurring in the uppermost beds, is different from any of those found in the Carboniferous Limestone, and it is possible that here we may have an example of a species which has changed during a long lapse of time, and has, in consequence, been enabled to outlive all its congeners. Above the eight-feet bed at Sweeney there are well defined trails of worms of considerable size, and these are associated with numerous fucoidal remains. The same grouping is seen in similar beds near Chork Castle, nine miles to the north. Reef-making corals, such as *Lithostrotion* and *Cyathophyllum*, do not appear in the Sandstone beds, but in the limestones of the Mold section, of equivalent age to the beds below the eight feet bed at Sweeney, they occur in abundance, illustrating the way in which genera, disappearing from one locality through unfavourable conditions, continue to survive in others under more favourable auspices; and suggesting also that,.as the successive formation are dove-tailed, so to speak, one into the other, rather than divided by sharp lines of separation, it is not wise to speak dogmatically of the age of certain epochs by fossil evidence alone.

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[1] "The Fossiliferous character of the Millstone Grit at Sweeney, near Oswestry, Shropshire," by W. Prosser, F.G.S., GEOL. MAG., 1865, Vol. II., p. 107.

It will be seen, from the foregoing remarks, that the fauna of the Millstone Grit bears a decidedly Carboniferous Limestone facies, but above the middle beds numerous remains of Coal Measure plants make their appearance: Calamite stems, for example, lying embedded amidst shoals of *Productus semireticulatus*, var. *Martini*.

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[1] Or, more probably, the grave of the *Cephalopoda*?—Edit.

In his "Geology of Yorkshire," Professor Phillips enumerates about 16 species of fossils obtained from the Millstone Grit of that county, but these were derived from the limestones, ironstone-nodules, and shales. The distinguishing feature of the Millstone Grit we are considering, is, that the fossils are obtained almost exclusively from its Sandstones, occurring in a beautifully perfect state of preservation in even coarse and pebbly grits, for example, in the Forest quarry, at Cyrnybwch, we find the sharp striæ and ridges of *Streptorhynchus crenistria* uninjured in the coarse sandstone, and lying in close proximity to pebbles. In this respect the matrix in which the fossils are imbedded differs from that in which the fossils described by Lieutenant Austin, from the Bristol district, are found. These are set in a matrix of calcareous sandstone, like that we find at the base and in the centre of the North Wales group. The fossils that occur in the beds of the North of England are interesting, as showing a similar fauna to that of North Wales, extending similarly upwards to the Coal Measures; and, as we cannot suppose that the fauna disappeared and reappeared with each change from calcareous to sandy conditions, we must conclude that there are nests of fossils somewhere, in the intervening sandstones, which have yet to be found.

There is an entire absence of seams of coal in the Millstone Grit of North Wales, and in this respect also it differs from that of the North of England. The presence of land-plants, however, renders it possible that, somewhere or other, there may yet be found the remains of an early Carboniferous flora in carbonaceous shales, or thin seams of coal. There is a line representing one of the latter on the geological map for the Owestry district, but this is an error. The coal on its course belongs to the true Coal Measures, and is not interstratified with the Grit, the portion between Mynyd Myfyr and Carneddau being a partially denuded outlier of the main field.

I have throughout this paper assumed that the rocks I have been describing are really Millstone Grit, but I am conscious that the correctness of this assumption has been questioned, indeed I think that I was myself the first to do so, for, in 1861, I wrote,[1] "The Yoredale series, which in Yorkshire presents an alternation of beds of shale, limestone, sandstone, and coal, is not represented in North Wales, *unless* we regard the uppermost beds of limestone and shale, and the lowest fossiliferous layers of Millstone Grit in our neighbourhood as occupying the same horizon, viz., lying between the limestone proper and the coarse and unfossiliferous Grits.[2] Mr. Green, of the Geological Survey, in a contribution to the GEOL. MAG., 1867, Vol. IV., p. 11, suggested pretty much the same division; and Mr. John Aitken, of Bacup, who has well studied the Grits of his own neighbourhood, thus wrote to me, after some excursions we

[1] Proceedings of the Owestry Field Club.

[2] At this date my knowledge of the extent to which the fossils extend upwards in the Grit was limited.

had made together near Owestry, "Your so-called Millstone Grit much perplexes me." It may not be amiss, therefore, in a few concluding remarks, to consider more fully this question.

The reasons urged for comprising the greater portion of the Millstóne Grit of North Wales with the Yoredale series are, as I understand them, as follows:—1. The presence of Carboniferous Limestone fossils; 2, the supposed greater resemblance of the Sandstones to the Yoredale rocks than to the Millstone Grit elsewhere; and 3, the intercalation of limestones with the sandstone beds. With regard to the first, it will be sufficient to repeat what I have already said, that we find the same fossils extending upwards through the Millstone Grit of the north, only as yet confined to the calcareous beds and shales; and further that we find these same fossils within a yard of the Coal Measures in that uppermost and most persistent member of the North Wales Grits, whose equivalency with the Millstone Grit is allowed by all. Secondly: it must be admitted that the sections of the Yoredale and Grit beds, taken from the Northern and Midland Counties, show great variations and gradations in the texture of the sandstones. Thus Professor Phillips writes:[1] "Now of all the strata of the Yoredale series, the limestones are by far the most continuous and permanent: had we attempted to construct the diagram of corresponding geological age, in distant parts of Yorkshire, by a comparison of the sandstones and slates, the results would have been most imaginary, and lines of demarcation in the Carboniferous series would have been worse than useless." By a comparison of the sections given in this paper with those given by the various authors who have described similar rocks elsewhere, it will, I think, be seen that, while the supposed Millstone Grit of North Wales will compare at various horizons for crystallization and pebbly grits with those of the north, these in their turn present us with shales and finer sandstones, similar to those of the Welsh Border.

Nor, thirdly, can the presence of the limestone in the middle portion of these beds be held as deciding the matter, because, in all the sections of the Millstone Grit, given by Professor Phillips, in his "Geology of Yorkshire," there are bands of limestone: indeed, there was an attempt once made I believe on this account to sweep the whole of Grits, etc., lying above what was known as the Hadrow limestone, including the Ingleborough Grits, into the Yoredale series. Professor Phillips having to contend, that it would be absurd to absorb a formation, whose distinctive characteristic was sandstone, into one whose distinctive characteristic was limestone, because of the occurrence of a few feet of the latter in the midst of the former. The same remark holds good of the North Wales sections, excepting that at Mold, and here I must confess the analogy ceases. Indeed, when I first saw this section, and saw the pale sandstones at the top pass downwards through purply calcareous sandstones into undoubted limestones, abounding in encrinital stems, as at all the other points of junction between the two formations, I was led to accept Mr. Green's suggestion, in the paper referred to, "that all the lower beds have thinned away before they reach Flintshire," and that I had reached the limestone proper, but as I descended the section passing various sandstones interstratified with the limestones, and finally found the mass of white and red sandstones at its base, resting upon what appears to be the main body of the Carboniferous limestone, my impression was altered, and the conclusion which, after much careful deliberation, I have arrived at is this; that in the southern half of their course, the whole of the beds between the Carboniferous Limestone and the Coal Measures do, on the North Wales Border, most nearly resemble the division of rocks elsewhere known as the Millstone Grit, but that in their northern portion, from the base of the white beds at the top of the Mold section, they have greater affinity with those described as the Yoredale series, with rather more of a calcareous element in their composition than the latter usually possess. I would therefore venture to suggest whether the time has not come when the *whole* of the beds lying between the Great Scar Limestone, and the Coal Measures, varying as they do in different localities, presenting many features in common, passing rapidly, as we have seen, in what I have called the North Wales district, from sandstone to limestone, and contrariwise, ought not to be united into one great group, with subdivisions according to locality and condition.

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[1] "Geology of Yorkshire," vol. ii.

NOTICES OF MEMOIRS.

I.—The Great Boulder Drifts of North America.

An Article on the "Relations and Characters of Western Boulder Drift," by E. Andrews, M.D., appeared in *Silliman's American Journal* for September last, of which the following is a brief abstract:—

The original Boulder-clay is beyond all question a stratified water-deposit. More than 2,000 miles of it have been exposed by waves along the shores of the great lakes, and along more than fifty railroads which have cut the hills in every direction. The meaning of the facts cannot be mistaken, and the western geologists most familiar with the sections *have been obliged to abandon the glacier theory*, and to admit the aqueous origin of the Boulder-clay under a sea floating vast quantities of ice. The original Boulder-clay is not only clearly stratified and cross-stratified, but marked by a peculiar style of undulation, and by the frequent occurrence of circular and oval valleys without any outlet. The most remarkable facts are those indicating the energy of the water during its deposition. As first observed by Professor Jewell, of Chicago, in a long tunnel, it contains two kinds of erratics, rocks and gravel-boulders, the latter sometimes three feet in diameter. The gravel must have been dropt from floating ice in frozen masses, and covered up before the masses had time to melt. The clay therefore must have been deposited with "unaccountable rapidity."

In Wisconsin, a remarkable valley, 400 miles long, runs mainly from north-east to south-west, with a gentle slope on the north-west side and a very precipitous slope on the south-east. A broad Silurian ridge, which separates this valley from Michigan, is covered by a thick, coarse, stratified, water-worn gravel, which, at a distance of twenty miles south-east, shades off into the Boulder-clay of Illinois. The central part of this gravel deposit rises up into hills 800 feet above the level of Lake Michigan. The hills are often sharp and conical, and interspersed with deep circular valleys without outlets, called the Potash Kettles. The gravel runs south-west about 200 miles, and is over 20 miles in width. In the northern part it is coarse, with rounded stones up to more than a foot in diameter, and yet thrown up into steep, round, lofty hills; but southwards the material becomes finer, and the hills lower, until they shade off into the Illinois Prairies. On the north-west side of the valley no gravel exists. The drift must have come from the north in *a vast sweep of water deep enough to cover gravel hills* 800 *feet high, and with a velocity sufficient to throw coarse material up into steep hills.* The uninterrupted sweep of the water down the gradual slope of the valley allowed no great deposits; but the current striking the opposite precipice must have been partly obstructed so as to throw it into extraordinary and irregular commotion, here piling up lofty gravel hills, and there leaving deep hollows, as it swept across the broad ridge. The finer matter must have been carried south, so as to settle as clay, and this accounts for the masses of frozen gravel dropped by icebergs into the clay, and covered up before the masses melted. A similar gravel-range flanks the south-west border of the valley of the Georgian Bay, Lake Huron.

The gravel hills, and nearly all the drifts of this region, are covered with a thin stratum of orange-coloured loam, from a few inches to several feet thick,[1] which follows all the undulations, excepting valleys of erosion. It is free from boulders, and must have been deposited in a quiet sea after the boulders ceased to arrive.

Near the north source of the Western Drift the violence of the aqueous action is evident. There is little or no drift on the north slope of the Laurentian Hills. The whole country has been scratched and pounded by the drift action, but the loose material has nearly all been swept southwards. "Not even boulders could keep their footing" in the current. The only exceptions to the sweeping action are where abrupt declivities fronted the north so as to oppose the current. There the finer matter is gone, but the boulders are piled up in vast slopes, with their surfaces rammed together like a pavement. Everywhere else there is smooth rock, only covered with a little vegetable soil. Hundreds of miles of smooth rock run along the northern slope of the Laurentian Hills. Facts testify to the drift action for a thousand miles east and west along the Laurentian Crest, and for an unknown distance north, having been too violent to admit of deposition. South of the Crest the water was less violent, and deposition commenced.

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[1] I have noticed a similar stratum of loam covering the drifts of Yorkshire and elsewhere.—D. M.

Dr. Andrews believes that the waters suddenly retired after the deposition of the orange loam, as, from the uplands of Wisconsin to the Ohio River, over a descent of more than 1,300 feet, no shingle-beach has been found. "It is possible," he continues, "that this sudden retirement, and the constant rush of waters, was the cause of the valleys of our streams being excavated to such an enormous breadth, compared with the feeble brooks that now meander through them."—D. M.

II.—New British Fossil Bird.—"On the Cranium of a Gigantic Bird (*Dasornis londinensis*, Owen), from the London clay of Sheppey, Kent." Under the above heading, Professor Owen has described and figured[1] the cranium of a large bird, which is interesting, not only on account of the rare occurrence of Ornithic remains in the British Lower Tertiary deposits, but also from combining certain characters of form and proportion with the large extinct birds of New Zealand, and also with the existing Struthionidæ. Like them, the Professor considers it to have been terrestrial in its habits. That it was of huge size is evidenced by the cranium, which is as large as that of the *Dinornis giganteus*, Owen, with which, and other species of Dinornithic and Struthionoid skulls it has been elaborately compared. Prof. Owen, in referring to the discovery of the large limb-bones (femur, tibia, and a portion of a fibula) of *Gastornis Parisiensis*, Heb., in the Plastic clay at Meudon, near Paris, thinks that it, like *Dinornis*, will "prove to be tridactyle and terrestrial," and that it is possible that this portion of skull may ultimately be found to belong to the same genus as the Parisian bird. The cranium of *Dasornis* is in the British Museum.—The same part of the Transactions contains two papers by Prof. Owen, in continuation of his many valuable contributions on the osteology of the extinct Birds of New Zealand—one on the sternum, the other on the cranium, of several species of *Dinornis*—both papers being illustrated with several plates.—W.D.

REPORTS AND PROCEEDINGS.

Geological Society of London.—January 26th, 1870.—Prof. Huxley, LL.D., F.R.S., President, in the Chair.—The following communication was read:—"On the Crag of Norfolk and associated Beds." By Joseph Prestwich, Esq., F.R.S., F.G.S. The author commenced by referring to his last paper, in which he divided the Red Crag into two divisions—a lower one, of variable oblique bedded strata, and an upper one, of sands passing up into the clay known as the Chillesford clay. In 1849 he had alluded to the possibility of this clay being synchronous with the Norwich Crag. He has since traced this upper or Chillesford division of the Red Crag northwards, with a view to determine its relation to the Norwich Crag. He has found it at various places inland, but the best exhibition of it occurs in the Easton Bavant Cliffs. He there found in it a group of shells similar to those at Chillesford, and under it the well-known bed of mammaliferous or Norwich Crag, with the usual shells. The author also showed that in this cliff and the one nearer Lowestoft traces of the Forest-bed clearly set in upon the Chillesford clay. He then traced these beds at the base of Horton Cliff, and then passed on to the well-known cliffs of Happisburgh and Mundesley. He considered the Chillesford clay to pass beneath the Elephant bed, and to represent some part of the Forest-bed. The same clay may be traced to near Weybourne. The Crag under these beds he referred to the Chillesford sands. Mention was then made of the sands and shingle above the Chillesford, to which the author proposed the names of "Southwold Sands and Shingle." These usually are very unfossiliferous, but at two or three places near Southwold the author found indications of an abundance of shells (*Mytilus*, &c.) and Foraminifera in some iron-sandstones intercalated in this series. In the Norfolk cliffs these beds contain alternating seams of marine and freshwater shells. The inland range of the beds to Aldeby, Norwich, and Coltishall was next traced, and the Chillesford clay shown to be present in each section, and the sands beneath to be referable to the Chillesford sands, as already shown by other Geologists, on the evidence of the organic remains. Mr. Gwyn Jeffreys, who had carefully examined the shells of the Norwich Crag for the author, stated that a considerable number of Arctic species were found in the Norfolk Crag which did not occur in Suffolk. While, therefore, the Norwich Crag seems to be synchronous with a portion of the Suffolk Crag, that portion is the upper division; and therefore the triple arrangement, proposed by Mr. Charlesworth and advocated by Sir C. Lyell, together with the fact of the setting in of a gradually more severe climate, pointed out by the late Dr. Woodward and by Sir C. Lyell, are confirmed.

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[1] Transactions of the Zoological Society of London, vol. vii., pt. 2, p. 145.

Mr. Prestwich then referred to the origin of the materials of the Southwold shingle, and showed that, with few exceptions, they came from the south. In it he had found a considerable number of worn fragments of chert and ragstone from the Lower Greensand of Kent. He considered this a convenient base-line for the Quaternary period, as then commenced the spread of the marine gravels over the south of England, and soon after commenced the great denudations which give the great features to the country.

DISCUSSION.—Mr. Gwyn Jeffreys observed that no littoral shells occur in the Coralline Crag; in the Red Crag they abound. In the Norwich Crag there is also evidence of littoral conditions, but in certain places the shells exhibit a deep-water character. In the Norwich Crag, after eliminating as derivative or extraneous certain species (as had already been done by the late Dr. Woodward), he finds, exclusive of varieties, 140 species, of which 123 are living, and 17 are supposed to be extinct. Of these 123, 101 still live in the British Seas, 12 are Arctic and North American, 8 Mediterranean, and 2 Asiatic. The southern species were probably derived from the Coralline Crag. The two Asiatic species were the *Corbicula fluminalis* and *Paludina unicolor*. Twenty species in the Norwich Crag have not been found in the Red or Coralline Crag, and he therefore thought there was some difference in their geological age, the Norwich Crag being both more recent than the Red Crag, and its shells of an Arctic or more northern kind. *Tellina balthica* he regarded as significant of brackish-water conditions. *Actæon Noæ*, a characteristic shell of the Red and Norwich Crag, had been found fossil by Prof. Steenstrup in Iceland.

Sir Charles Lyell had been struck with the similarity of the beds at Chillesford and at Aldeby, in which also the shells, though 40 in one case and 70 in the other, were very similar in character; but in neither was *Tellina balthica* found, though common in the glacial beds. He called attention to the condition of the shells as they occurred at Aldeby, and suggested that where the two shells of a bivalve were found in contact, they would probably afford some evidence whether they were derivative or no.

Mr. Searles V. Wood, Jun., was inclined to differ to a large extent from the author, especially with regard to the beds above the Chillesford Clay. The sands containing *Tellina solidula* he placed as the lowest member of the glacial series; the fauna they contain is different from that of the Chillesford bed. He regarded the sand-beds at Kessingland as above the lower Boulder-clay and contorted Drift of Cromer, and considered that it might be traced as occupying this position along a great part of the coast of Norfolk. He had, in company with Mr. Harmer, surveyed a great part of the Norfolk and Suffolk district, and they intended to place their maps and sections at the disposal of the Geological Society and the Survey. He recommended that any examination of the country should commence from the east rather than from the west.

Mr. Boyd Dawkins, speaking of the fossil mammalia of the Crag, mentioned that, at the base of the Crag at Horstead, immediately on the Chalk, was a bed exhibiting an old land-surface, and in this were found the principal perfect mammalian remains, whereas in the Crag above they were waterworn. But though these bones occurred in the marine deposit, the animals had lived on the land, and there was no evidence but that they belonged to a much earlier period than that at which it was submerged. He thought that the facies of the Cervidæ found at Horstead was that of an early Pliocene age. The mammals of the London Clay had in some cases become confounded with those of the Suffolk Crag, but these he regarded also as belonging to an old Pliocene land-surface. He differed from the author in not regarding the forest-bed as Quaternary, as the remains of *Rhinoceros etruscus*, *Ursus arvernensis*, and *Elephas meridionalis*, &c., had occurred in it in many cases in fine condition. He could see no reason for splitting up the Cainozoic series into four divisions, as there was no break in the life between the Tertiary and Quaternary periods. Though there might be a break in England, the forms of life were continuous from the Miocene of Pikermi on the Continent.

The President suggested that if we were to admit a Quaternary period, we must go back to the Miocene, as the mammalian fauna of that period was the direct ancestor of that of the present day.

Mr. Prestwich, in reply, remarked that he did not quite agree with Mr. Jeffreys as to the number of derivative species in the different members of the Crag. The fauna, however, required further investigation. With regard to the objections of Mr. Wood, he had not on this occasion intended going into details as to the beds above the Chillesford clays; his object had rather been to show that these latter extended over a large area, and contained, in other places than Chillesford, the same shells as those occurring there. He did not attach the same value to the presence of *Tellina balthica* as did Mr. Wood, it being a shell now living, and found on the coast. He had not overlooked the importance of the mammalian remains, but, like Mr. Dawkins, he had felt the uncertainty which, in the case of the Crag, so often attached to their origin, and therefore had not much insisted on them. He thought the divisions of Miocene and Pliocene were well known and generally accepted, and though the division was arbitrary, he thought the setting in of the Glacial period a good epoch at which to commence the Quaternary period. If we were to go back to some break in the forms of life, we might go back indefinitively.

II. February 9th, 1870.—1. "On the Fossil Corals (Madreporaria) of the Australian Tertiary Deposits." By P. Martin Duncan, M.B. Lond., F.R.S., Sec. Geol. Soc., Professor of Geology in King's College, London.

The author noticed the history of our knowledge of the South Australian Tertiary Deposits, and indicated the general distribution of the fossiliferous beds from which the corals forming the subject of his communication were derived. These were said to be confined to the region west of Cape Howe, prevailing especially in the province of Victoria, where they had been admirably surveyed by Mr. Selwyn and the officers under him, and to consist chiefly of limestones covered, and in some cases underlain, by great outflows of basalt. The author then gave a list and descriptions of the species (31 in number) of fossil Madreporaria obtained from these South-Australian Tertiary beds, followed by remarks on the characters and relations of the more remarkable forms, and on the localities where they have occurred. From his examination of these fossils, he objected to the application of the divisions adopted in European geology to the deposits in which they are found. He then compared the assemblage of corals obtained from the South-Australian Tertiaries with those found in various deposits elsewhere, or living in the existing seas. The species were stated not to belong to reef-building forms, but to such as now occupy the sea-bottom from low spring-tide mark to the depth where Polyzoa abound. Of these, 20 genera were said to be now represented in the Australian seas; but only three of them to have species in the Tertiaries, viz. the cosmopolite *Trochocyathus*, *Flabellum*, and *Amphihelia*. The fossil species of these were stated to be quite distinct from those now living in the neighbouring sea. Two species, viz. *Flabellum Condeanum* and *F. distinctum*, are living in the Chinese, Japanese, and Red Seas; the author's *Plecotrochus elongatus* is very nearly allied to the Chinese *P. Condeanus;* and a *Deltocyathus* is regarded by the author as only a varietal form of a living West Indian and European Miocene species (*D. italicus*). Three species are common to the Australian and European Cainozoic deposits. Several of the species were said to present curious anomalies of structure, such as so frequently appear in Australian forms, and those of the different beds to exhibit so close a general resemblance, that they offer no evidence of great changes having taken place during the deposition of the whole series of sediments. The evidence afforded by the fossil corals led the author to conclude that, at the time of the formation of these deposits, the central area of Australia was occupied by sea, having open water to the north with reefs in the region of Java, and with openings into the Mediterranean and Sahara to the north-west; that Continental India did not form part of a great continent; that the greater part of America was submerged, and the Caribbean sea a coral-area; that the bulk of the land was situated in the north and south; and that the upheaval of Australia and New Zealand was approximately synchronous with that of the great mountain-chains of the Old World, with the closure of the Panama area and the depression of the areas on either side of the American continent.

DISCUSSION.—The President inquired whether the absence of reef-corals might not be indicative of the climate of South Australia having been much the same as at present in Tertiary times, as these forms required a temperature of about 68°.

Professor Ramsay expressed his satisfaction at the manner in which Mr. Selwyn's work on the Australian Geological Survey had been appreciated by the author.

Mr. Jenkins, who had been working on the fossil mollusca of Australia, had arrived at the conclusion that at the time of the deposit of the beds mentioned by Dr. Duncan, the climate had been warmer than at present. The shells presented the same strange and abnormal features as the corals, in differing from other older and well-known species merely in some minute detail. There was no point of contact between the Australian and European faunas to afford a criterion of relative age, though there were some points of similarity to be found in the Mediterranean area.

Mr. Gwyn Jeffreys stated, as an instance of the singularities of the Australian fauna, that *Rhynchonella psittacea*, essentially an arctic species, had occurred in the tertiaries of Spain, in our Glacial deposits, and the Norwich Crag, and is now found living in Australia.

Dr. Duncan shortly replied to the various speakers, and was disinclined to limit the occurrence of any forms of coral to particular temperatures.

2. "Note on a new and undescribed Wealden Vertebra." By J. W. Hulke, F.R.S., F.G.S.

The author in this note describes a very large Wealden vertebra which he obtained last autumn at Brook, Isle of Wight, remarkable for its great size, its extremely light structure, and the extraordinary development of the processes connected with the neural arch. It consists of a thin outer shell, enclosing a very open cancellated tissue, having extremely large spaces, comparable with those of Pterosauria, and surpassing those of the cancellous tissue in any of the known larger Dinosaurs. A wedge and notch, similar in principle to the ophidian zygosphene and zygantrum, but differently placed, are superadded to the ordinary articular processes. A broad horizontal platform stretches along the side of the arch from the transverse process to the postzygapophysis. The neural spine is composite; all the outstanding parts are supported and strengthened by thin bony plates. Only a small part of the centrum is preserved, so that the form of this, and in particular of its articular faces, is not determinable. The author notices, in conclusion, certain textural resemblances between the vertebra and a peculiar Streptospondylian vertebra in the British Museum, from the Weald of the south-east of England.

Discussion.—The President remarked on the combination of strength and lightness in the bone, which in this respect was not unlike that of the vertebræ of the neck of the ostrich.

3. "Note on the Middle Lias in the North-east of Ireland." By Ralph Tate, Esq., A.L.S., F.G.S.

The author remarked that hitherto no higher member of the Jurassic series than the Lower Lias has been detected in Ireland. He stated that he had received from near Ballintoy some blocks of a grey, marly, micaceous sandstone, containing an assemblage of fossil forms, indicating that the rock from which they were derived belonged to the lowest part of the Middle Lias. The origin of these specimens, which were obtained "from cultivated fields and patches of drift," was said to be still unknown: and the occurrence of *Hippopodium ponderosum*, associated with Middle-Lias species, as in the island of Skye, coupled with the agreement in lithological composition between the Irish blocks and the Pabba shales, led him to suggest the possibility that the former may have been transported from the Hebrides by glacial action.

EDINBURGH GEOLOGICAL SOCIETY.—At the second ordinary meeting of the Society for the present Session, held on 2nd December, 1869, A. Geikie, Esq., F.R.S., etc., President, in the chair, the first paper was "On the Succession of the Laurentian, Cambrian, and Lower Silurian Rocks on the Shores of Loch Broom," by Sir Roderick I. Murchison, Bart., K.C.B., etc., being a letter addressed to the President. . . . . "The few additions which I made last summer to my acquaintance with the Highland rocks were in the west of Rossshire, and particularly on the shores of Loch Broom, a district which I rapidly traversed with Professor Sedgwick in 1828, and to a part of this very Ullapool you extended the researches we were making together in 1860. What I have to state is the result of a visit to my friend, Mr. John Fowler, the eminent engineer, and proprietor of a large extent of Highland country at the western end of Loch Broom, who has erected a noble mansion called Braemore, which, being nearly 700 feet above the sea, commands an extensive view over Loch Broom up to the mountain of Ben More. Possessing a small steam-yacht, he enabled me to make excursions to points which I had before only seen very imperfectly. In this tract—*i.e.*, from the numerous low Summer Isles which crowd the outermost or western portion of the sound—the Priest and others of them are composed chiefly of the Fundamental Gneiss, which in 1859 I paralleled with the Laurentian rocks of North America. Also, on one of the promontories of the southern mainland, called Cailleach, this Laurentian gneiss is seen to throw off, on its broken edges, patches of the coarse reddish brown grit and conglomerate which constitute the southern shore of Loch Broom; the Cambrian grits being thrown off at various steep angles. On the northern side of the loch, however, the same Cambrian rocks constitute the whole of the lofty mountain of Ben More, the strata of which are clearly seen from the water to constitute a succession of terraces very slightly inclined to the east, and thus exhibiting a thickness of several thousand feet. Some of the lowest portions of these Cambrian rocks consist of hard schists. As a whole these rocks are precisely similar to those of the same age which I had formerly described in Sutherland. Their lithological characters are also similar. Thus, the Laurentian gneiss at the point of Cailleach is like that of Loch Inver, essentially a hornblendic, rough, thick-bedded gneiss of highly crystalline aspect, and more or less dull greenish colour, occasionally quite finely laminated, and showing, by the arrangement of the quartz and felspar within it, a bedded character, with small crystals of garnets occasionally disseminated. At this locality it only differs from the bottom rocks of Sutherland and the Lewis in being less granitic, and with fewer interpolations of pure granite. The Cambrian rocks which overlie transversely that Laurentian gneiss are essentially, as in Western Sutherland, coarse grits, in parts conglomeratic, and made up of the materials of the older gneiss—*i.e.*, of quartz, hornblende, and felspar—but, like the parent rock from which they have been derived, they contain little or no mica. These sandstones and grits, for the most part of a chocolate reddish brown colour, are those which were formerly identified with the Old Red Sandstone, from which, as I have shown elsewhere by transverse sections and descriptions, they are separated by the whole series of Lower Silurian rocks in a crystalline form. The lowest members of these Lower Silurian rocks are white and grey quartz rocks, regularly stratified, with intercalated bands of limestone. This lower portion of the Silurian series overlaps quite unconformably the Cambrian rocks on both sides of Loch Broom, and their relations are all well and clearly seen near Ullapool, where the overlying quartzites assume a much higher inclination than the sandstones on which they rest. . . . In ascending Loch Broom to its western extremity on the mouth of the river Broom, nothing can be clearer than the underlie of all the rocks hitherto mentioned to the upper gneiss of the region in which are situated the glen of the river Broom, with the mountains on either side of it. There is, however, one intermediate spot above Ullapool, where the loch narrows, and where the promontories on either side (one of which is called Loggie) consist of diversified rocks, apparently the result of separate intrusion and metamorphism. In these I met with dark diorites passing into serpentinous rocks, light, green, granular, felspathic lumps, and here and there compact felspar rocks, of pinkish hue. Those convulsed and broken spots, where the hard rocks have resisted denudation, and consequently form the narrows of the loch, require to be more thoroughly examined. This, however, is certain, that these peculiar rocks are perfectly distinct from all the older rocks hitherto mentioned, and are entirely unlike any portion of the upper gneiss, with which my little sketch terminates. This Upper or Lower Silurian gneiss is at once distinguished from the fundamental or Laurentian and non-micaceous gneiss by its flaglike character, and by its containing such an abundance of mica as to be in parts almost a mica-schist. It is, however, the grey quartzose variety of the gneiss of Macculloch, and is distinctly seen to overlie all the previously-described rocks, no one of which does it in any way resemble. It has been usefully turned to building purposes by Mr. Fowler, who has erected out of it the mansion of Braemore. It is regularly bedded, and, dipping to the E.S.E. at small angles, ranges into lofty mountains, which extend to Glen Fannich in the west and to Ben Derrig in the south. It is occasionally traversed by small granite and white quartz veins, and in such cases is often charged with crystals of iron pyrites. In its extension to the S.E. the rock is traversed also by large bosses of red granite, and then rolls over in undulations from the valley of the Blackwater, until it occupies the greater part of Ben Wyvis, the loftiest mountain in Ross-shire. Their order of superposition and the unconformity of these Lower Silurian rocks, whether quartz rocks and limestone or the upper gneiss, are perfectly clear and unmistakable; and when we couple these facts with the striking diversity of mineral character between the lower or Laurentian and this upper flaggy micaceous quartzose gneiss, and see that they are separated by mountain masses of Cambrian sandstone, the only wonder is that it was left to me in my old days to indicate this order. It was, therefore, a great pleasure during the last summer to see the phenomenon so well sustained by a fresh appeal to the successive rock formations on the north and south flanks of Loch Broom."

Mr. Archibald Geikie, F.R.S., communicated the second paper, entitled "Notes for a comparison of the Volcanic Geology of Central Scotland with that of Auvergne and the Eifel." The author began by alluding to the labours of Boué, Forbes, Scrope, Daubeny, and others. He then sketched the area occupied by rocks of volcanic origin between the Grampians and the Silurian uplands of the southern counties. The rocks which he proposed to make the subject of more special remark in this paper were of Carboniferous age. They were capable, he said, of being broadly treated under two groups: 1st, Plateaux; and 2nd, Points of local eruption.

1. Plateaux of Carboniferous volcanic rocks are extensively developed in the western part of the midland valley. They form the range of the Campsie and Kilpatrick Fells, and, crossing the Clyde into Renfrewshire, sweep for many miles through the north and north-east of Ayrshire. They occur likewise as fragments on the Clyde islands, Arran, Bute, and Cumbrae. Extensive as the present area of these rocks is, there can be no doubt that it once covered a much greater surface, and that one great plateau of lavas and tuffs stretched from the Ochil Hills to the south of Cantyre. Throughout the wide district where the rocks still remain, they retain a remarkable horizontality. They consist of various porphyrites, melaphyres, and tuffs arranged in beds, which are placed over each other with great regularity. Hence the hillsides wear a terraced appearance from the alternation of harder and softer beds. This feature characterizes the Campsie Fells and the hills south-westward to Ardrossan, but is most conspicuously displayed in some of the valleys at the south end of Bute. One of the distinguishing features of these plateaux is the comparative infrequency with which any vent or true point of eruption can now be detected. Occasionally such a vent is found as a boss of coarse volcanic agglomerate, or of porphyrite or melaphyre; but, as a rule, all the foci of eruption are now buried under the materials which they emitted. Another feature which runs through the plateaux is the apparent continuity of the several beds. Viewed from a little distance, the terraces of trap seem each perfectly continuous for long distances. A closer examination often shows that, though the terrace may run on, the rock of which it consists is formed of different sheets, which, though lying on the same plane, have proceeded from different vents. Mr. Geikie then pointed out the structure of some of the volcanic plateaux of central France as illustrative of those features of the Scottish plateaux to which he had referred.

2. While the western half of the Scottish Carboniferous area is characterized by the wide extent of its volcanic plateaux, the eastern half is as strikingly distinguished by the abundance of its points of local eruption. Traces of these independent but closely segregated vents are scattered over almost the whole extent of Fife and the

Lothians. They belong, as a whole, to the lower division of the Carboniferous formation. The evidence by which their position can now be ascertained consists of masses of stratified tuff, frequently associated with contemporaneous outflows of melaphyre. The number of the vents in some parts of the country must have been very great. During the deposition of the Lower Carboniferous rocks the area of Linlithgowshire and great part of Fife and East Lothian was dotted over with little volcanoes, each throwing up its cone of ash, or here and there emitting a short current of lava. In some places the vents were so closely placed together that their ejections formed in the end one long volcanic bank, such as the Garlton Hills, and the range of heights between Bathgate and Linlithgow. The vents were singularly local in their development. Thus, while they continued in activity throughout Linlithgowshire and Fife, as well as in Haddingtonshire, the intervening area of Edinburghshire remained almost without them. Their long continuance in the districts where they had once broken out is remarkable. During the time represented by the deposition of many hundred feet of strata, the area of Linlithgowshire continued to be the theatre of a wonderful volcanic activity, new cones breaking out as the old ones were washed down. Yet the county of Edinburgh, only a few miles to the east, remained during that long period almost wholly unaffected by any volcanic action. Reference was then made at some length to the extinct volcanoes in Auvergne and the Eifel, and it was shown that in their form and distribution, their small size, the nature of their products, and the protracted period during which they had been in activity, they enable us to realize vividly what was the condition of a great part of central Scotland during the earlier ages of the Carboniferous period.

The concluding portion of the paper dwelt upon the denudation of the volcanic rocks of Auvergne and of Scotland. Mr. Scrope had shown conclusively that the wide and deep valleys of the Loire, the Dordogne, and other streams of central France had been carved out of volcanic rocks and fresh-water strata by subaërial erosion alone. The form and structure of these valleys were compared with those of valleys which have been excavated out of volcanic rocks in Scotland, and it was argued that the similarity of result was in all probability due to a similarity of cause. In the Scottish valleys the influence of ice, and perhaps in some cases also of the sea, had come into play to augment or modify that of the subaërial forces. Yet there was every reason to believe that in Scotland, as in France, the main share of the work had been done by rains, frosts, and streams.

GEOLOGICAL SOCIETY OF GLASGOW.—I. The ordinary meeting of this society was held in Anderson's University, on the 11th November, 1869, Professor John Young, President, in the chair.—Mr. John Young exhibited and made some observations upon a number of bones found near Crofthead, in the new railway cutting of the Crofthead and Kilmarnock Extension Line. Mr. Young stated that Dr. Young and himself had examined the bones, and found that ten of them belonged to the horse, about one-third smaller than the average size, but probably of the common species—*Equus caballus*. Two others were portions of the horns of the extinct "Irish deer" —*Megaceros Hibernicus*. These remains were found in the upper portion of a thick bed of laminated clay, which at this part of the valley is mixed up with so much vegetable matter that it presents quite a peaty character. They lay on the same horizon, and near to the spot where the skull of the *Bos primigenius* was found some time ago. The depth at which they occurred below the old surface of the valley is nearly 20 ft., but recent cuttings seem to show that part of the overlying bed is the result of slips of earth and Boulder-clay from the hill-side, over deposits formed in the bottom of an old lake.[1] This appears to be the second instance in which the "Irish deer" has been found in Scotland. Mr. Young also stated that this seems to be the first recorded instance in which the remains of the horse have been found associated with the large extinct mammals that roamed in the valleys of Scotland in Post-Pliocene times.—Mr. Robert Craig then read a paper on "Sections of Boulder-clay in the North of Ayrshire, and at the railway cutting in Cowdonglen, near Crofthead, Neilston."

II. Ordinary meeting, 2nd December, 1869, Mr. John Young, Vice-President, in the chair.—Mr. J. Wallace Young read a paper "On the Application of the Microscope to the Examination of Rock-Structure and Composition." The author advocated the microscopical examination of rocks. By this method Geologists would be enabled to distinguish rocks of igneous from those of sedimentary origin. A number of sections of rocks were exhibited by Mr. J. W. Young, in illustration of his paper.

The following three papers were then read by Mr. James Thomson, F.G.S.:—(1) "On the Teeth of *Pleurodus*." Mr. Thomson exhibited a slab of the Airdrie blackband ironstone, one of the surfaces of which, covered with shagreen, contained upwards of sixty-five teeth, belonging to what have hitherto been regarded as three distinct species of Carboniferous fishes, viz., *Pleurodus Rankinii*, *P. affinis*, and a *Helodus;* but from sections prepared, which were shown under the microscope, and from investigations which he had made regarding the teeth and dermal structure of some of the living rays to which they are allied, he was of opinion that the three varieties of teeth on the slab all belonged to one species only. (2) "Note on the Discovery of Plants in the Schists of Argyllshire." Mr. Thomson exhibited specimens of two different plants which he had discovered in a dark-grey arenaceous shale near Campbeltown. One, marked with longitudinal parallel lines, resembles *Sigillaria;* the other *Calamites* of the Coal-measures. Mr. Thomson said he believed these plants to be the first traces of organic remains yet recorded from the schistose rocks of the British Islands, hitherto deemed unfossiliferous. (3) "On the Teeth and Dermal Structures found associated with *Ctenacanthus*."

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[1] See Mr. James Geikie's paper in the GEOL. MAG. for February last, p. 68.

III. Ordinary meeting, 13th January, 1870, Mr. John Young, Vice-President, in the chair.—Mr. James Thomson read a paper "On Further Evidences of the Existence of Plant-remains in the Schistose Rocks of the West Highlands." Mr. Thomson referred to the paper which he had read at the previous meeting, in which he had mentioned the probability of the occurrence of plant-remains in other parts of the West Highlands. This he had now been able to confirm by having found fragments of wood in a conglomerate, composed of talcose schist, with rounded pebbles of quartz, in Glencoe, where it occurs intercalated between beds of schist, which overlie the granite of the district. Mr. Thomson also read a paper "On the Vitrified Forts of Dunskaig and Carradale in Kintyre." He described the form of these forts, and drew attention to fragments of charred wood which he had found imbedded between the angular pieces of the schistose rocks of which they are built. The walls of each of them are about 6 ft. thick, and on examination he had found that they were only vitrified half through. It was evident, therefore, that the forts had been vitrified by means of the wood found imbedded among the stones, and that it had also been applied along the inner boundary only.

Mr. D. Corse Glen read a paper "On the Zeolites which occur in the Trap Rocks in the neighbourhood of Glasgow," illustrated by a large collection of these interesting minerals from his own cabinet.

IV. This Society met in Anderson's University, on the 27th of January, 1870.—Mr. John Young, Vice-President in the chair.—Mr. Wm. Cameron read a paper on the "Sutherland Gold-fields."[1] He referred to a paper which he had read before the Society in 1866, upon the auriferous rocks and drifts of Victoria, in which he had stated that it was possible that there might yet be found in Scotland fields where, with modern appliances, gold might be profitably worked. What he then merely hazarded as a conjecture has since been realised as a fact, and he had much pleasure in coming before them to give some account of his own experiences on a modern Scottish Gold-field. He first pointed out the principal geological features of the district. With the exception of certain strips and peaks of Old Red Sandstone, large grained granite and Oolite, the whole of the country immediately surrounding the diggings consists of metamorphic Lower Silurian rocks. No discovery of gold *in situ* has yet been achieved, so that the question as to what is the true matrix of the Sutherland gold is somewhat perplexing, and is exciting amongst geologists a considerable degree of interest. The drifts in which it is found are various, fine grained gold and even small nuggets having been obtained in various strata, from the bed rock to the roots of the heather. It exists in bands of black ferruginous drift, almost of the nature of cement, containing washed boulders of gneiss, granite and schists. There are occasionally two distinct bores at low water, and that its holes run *at various angles* to the horizon, one hole very often cutting through another at nearly right angles. The holes in inland or supra-marine limestone districts are frequently bored through each other. Mr. Mackintosh is of opinion that the *Pholas* can bore upwards; it is certain that the *Saxicava* can do so.

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[1] For more detailed and scientific information respecting the geological structure of the Sutherland Gold-fields, *vide* a paper by the Rev. Mr. Joass, of Golspie, Quart. Journ. Geol. Soc., vol. xxv., 1869.

In different parts of England and Wales Mr. Mackintosh has observed great numbers of borings in limestone rocks, at various altitudes above the sea-level. They seldom ran vertically upwards from the underside of a stone *in situ*, but were not infrequently horizontal, and sometimes directed at a small angle downwards. In no instance has he found a live snail in any of these holes. All his observations tend to militate more or less against the theory that the holes have been excavated by snails.

DENUDATION OF THE LAKE DISTRICTS.—MR. MACKINTOSH offers a few remarks respecting Mr. J. C. Ward's article in the January number of the GEOLOGICAL MAGAZINE (p. 14). The assumed probability that the sea, during the Glacial submergence, was an immovable frozen mass (an indispensable prop, as he considers, to the subaërial theory), is opposed by four facts:—1. The proximity of the Lake District to the southern border of the ice-covered region; 2. The diminution of cold consequent on the diminished extent of high land, when the area of Great Britain was reduced to the condition of small islands; 3. The intensity of marine action, proved by the enormous accumulations of drift in areas contiguous to the Lake District; 4. The transportation of boulders from one part of the Lake District to another, and from that district to surrounding areas, proving the activity of oceanic currents.

Mr. Mackintosh objects to the existence of fallen débris (or screes) on steep slopes being brought forward as a proof of sub-aërial origin of valleys. The valleys existed before the débris began to fall, and now they are in course of being obliterated.

The carrying powers of the streams in the Lake District is in most places truly insignificant when compared with the rate of accumulation of screes.

Mr. Ward disputes his assertion that the escarpments generally face the east, south-east, or north-east. Mr. Mackintosh remarks that the term escarpment ought not to be confined to the outcrop or upcrop side of a ridge, because this side is not always marked by the most regular, steep, and continuous slope. He would like to be informed of the existence of a long, steep, continuous slope, with or without cliffs, facing the north-west, west, or south-west, to the east of a line drawn from Blackcombe to Skiddaw Forest, with the exception of the Wallow Crag escarpment (which nearly coincides with a fault), and Loanthwaite Crag. The greater part of the Lake District lies to the east of this line. Two or three exceptional cases might be found, but Mr. Mackintosh has not met with any.

To the west of this line, as he has elsewhere remarked, the principal escarpments face various points of the compass.

PALOPLOTHERIUM ANNECTENS, OWEN.

SIR,—The specimens described, June, 1847, as of *Paloplotherium annectens*, being of an immature individual with the last lower molar, *en germe*, in its formative alveolus (Quart. Journ. Geol. Soc. Vol. iv. pl. 3, fig. 4) the hind lobule was not calcified. Subsequently receiving from Hordwell the mandible of an adult, I had it placed by the side of the first specimen, and labelled with its name in the British Museum. The rapid accumulation of materials has delayed the Second Edition of my "British Fossil Mammals;" but the rectification of the characters of *Paloplotherium* was made by PICTET in the Second Edition of his excellent "Traité de Paléontologie," vol. i. p. 312 ("la dernière a trois lobes.")

RICHARD OWEN.

THE LIQUEFACTION OF ROCKS AND "VOLCANOS."

SIR,—My error against Dr. Sterry Hunt and Mr. Scrope, conjointly, was committed in the pages of *Scientific Opinion*, and I acknowledged it in the same publication as soon as Dr. Hunt had shown me that I was wrong. I suppose that I did not read Dr. Hunt's paper, when it appeared in the Magazine in June last.

But I submit that that has not disposed of my letter to you, written a year ago.[1] For in the sentence which he quotes from "Volcanos," p. 266, it is evident that the author is referring to changes in the condition and mass of the volcano itself; because he immediately instances the sealing up of a fissure by cooled lava, and the accumulation of ejected matter. Changes of pressure, arising from movements in the earth's crust, through the cooling of its general mass, are not suggested.

I am bound to thank Dr. Hunt for his favourable mention of my paper as a whole. O. FISHER.

P.S.—*Erratum*, at p. 59, line 21, for "fused," read "glassy."

MISCELLANEOUS.

Professor OWEN has recently received, with remains of *Diprotodon*, etc., from the lacustrine deposits, Darling Downs, Australia, portions of a Crocodile, in similar fossil condition, which he determines to be identical with the species of Crocodile still existing in the Queensland rivers.

ILLUSTRATIVE GEOLOGY AND PALÆONTOLOGY.—A very effective chart of British Geology, suggested by Mr. Henry Cole, C.B., for the Technical Education System, has been recently carried out by Mr. James R. Gregory, geologist, of Russell Street, Covent Garden, and is placed in the South Kensington Museum. It is chiefly compiled from, and intended to illustrate, Professor Morris's Geological Chart. The names of the formations, the uses to which the rocks are applied in the arts, and the localities where they are best exhibited, are duly enumerated on cardboard, to which are attached, in parallel lines, various fossils and a few rocks, characteristic of each formation. The specimens are necessarily small, but when the representation of a larger form appears requisite, an engraving is substituted. The Norwich Crag, for instance, is illustrated with the following specimens:—*Nucula Cobboldiæ, Tellina obliqua, Cardium edule, Littorina littorea, Purpura lapillus*, and a small engraving of a Mastodon's tooth. The Mountain Limestone is illustrated with 25 specimens, and so on. More than 400 fossils and rocks are here displayed in four cases, and altogether they form a very useful diagram for educational purposes.

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[1] GEOL. MAG., Vol. vi., p. 46.

SIR WM. E. LOGAN, LL.D., F.R.S., F.G.S., DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.—"The retirement of Sir William E. Logan from the Geological Survey" (says the *Daily Globe*, Toronto) "will be received with regret by all who are acquainted with the faithful services which he has rendered to the country. Sir William Logan is a man of learning; his achievements in his own particular subject have earned the applause of scientific bodies in Europe, who are the best qualified to judge of their value. But Sir William is also a man of strict honesty, and, what is not so often found in men of science, is possessed of remarkable common sense. Many times his statements in reference to economical minerals have been questioned—sometimes even with what appeared at the moment to be justice. Experience, however, invariably proved him to be right. He has always wisely and prudently guarded his statements, so as to prevent reckless expenditure of money in unproductive mines, while he has given all needful encouragement to reasonable and intelligent hopes of a financial return. It is something for him to say, in leaving the Survey, that his statements have deceived no one; that not one dollar has been expended by reason of errors or too sanguine statements on his part. In the choice of his subordinates, and the expenditure of monies allotted to him by the Legislature, he has been all that the Government and the public could desire. It may safely be said that from no other department of the Administration have such results been obtained as from the Geological Survey. We part from Sir William Logan with regret, but congratulate ourselves that, though laid aside from public duty, he is still by no means incapable of labour; and we trust that he may live many years to enjoy the honours which he has so well earned. We know nothing of Mr. Selwyn, his successor; but Sir William Logan's recommendation is sufficient of itself to secure his appointment; the public will judge him afterwards by his labours."—Although Mr. ALFRED R. C. SELWYN may not be known to the general public in Canada, yet he is very well known to scientific Geologists in Britain and elsewhere—first, by his labours in connection with the Geological Survey of Great Britain; and afterwards by the able manner in which he conducted the Geological Survey of Victoria, till the necessities, parsimony, or ignorance of that Colonial Government induced its Ministry to stop the work, and pay off all the officers, of a Survey which took rank with the best-conducted Geological Surveys in the world.—EDIT.

A Sedgwick

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ORIGINAL ARTICLES.

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EMINENT LIVING GEOLOGISTS.

I.—Rev. Adam Sedgwick, M.A., LL.D., F.R.S., Woodwardian Professor of Geology in the University of Cambridge.

(With a Portrait.)

IN every branch of Natural Science there are earnest zealous workers, whose life-long devotion to its cause entitles them to be warmly remembered and even beloved, especially when their labours have been protracted over more than half a century; so long indeed, that to many of the scientific youth of the present day they are only known by name.

Such an one is the now venerable Adam Sedgwick, Woodwardian Professor of Geology in the University of Cambridge, and certainly one of the most eminent of living geologists.

Mr. Sedgwick was born at Dent, in Yorkshire, June 1784, and entered Trinity College, Cambridge, where he graduated as 5th wrangler in 1808, and was elected, in 1810, a Fellow of Trinity College, of which he is now the oldest member. In 1818 he succeeded Prof. Hailstone in the chair of Geology, founded at Cambridge by the celebrated Dr. John Woodward.

At this period little was known in England of geological science, but a general notion prevailed—agreeing closely with old Dr. Woodward's theory, who founded the chair—that *all fossils* were the result of a universal Deluge which had once swept over the whole earth, and to the agency of which all the strata owed their origin. For notwithstanding the writings of Werner, Hutton, and Playfair, William Smith, and others, already in existence, only the key-notes of geological science had as yet been touched, and it was needful that the patient labours of many such men should accumulate for years before the full chord of geological harmonies could be evoked.

Mr. Sedgwick's paper on Devon and Cornwall, read before the Cambridge Philosophical Society in May, 1820, and published in 1822, was the result of work done by him as early as 1819.

He saw then that the Plymouth fossil corals could not be identified with, *and were older than those of the Mountain Limestone* (pp. 93, 142, vol. i., Cambr. Phil. Trans.). It is interesting to note here that he was one of the secretaries of the Cambridge Philosophical

Society, at its establishment in 1819, and has frequently been an office-bearer since.

In 1818 he was elected a Fellow of the Royal Society, and in the same year he was also made a Fellow of the Geological Society of London. In this last-named Society he filled several offices, and in 1830 was elected President, holding the post for the usual term of two years, and delivering the annual addresses to that learned body.

In 1836, Prof. Sedgwick and Mr. (now Sir Roderick) Murchison communicated to the British Association at Bristol, a paper on the Culmiferous strata between Dartmoor and the north-west of Devon, pointing out, for the first time, the true geological position of these deposits.

In June, 1837, they gave to the Geological Society their account of the whole district—"for they not only attempted to describe the order of the successive formations north of Dartmoor, but also to bring them into comparison with the formations which are expanded from the South side of the Dartmoor granite to Start Point, and to the other headlands of the south coast of Devon." Sir H. De La Beche, Mr. James Sowerby, and Mr. Austen, on the other hand, regarded the Plymouth and Newton Limestones at that time as *Carboniferous.*

In 1838 Mr. Sedgwick re-surveyed the country south of Dartmoor, and Mr. Lonsdale, Mr. James Sowerby, and Mr. Phillips, examined the fossils.[1]

In March, 1839, Professor Sedgwick and Sir Roderick Murchison adopted their final classification of the older sedimentary rocks of Devon and Cornwall.

Mr. Lonsdale speaks of the "bold removal of the whole of the schistose and greywacke rocks of Devon and Cornwall to the Old Red Sandstone," as "a generalization which could only arise from long, patient, accurate, and extensive practice in the field; and a willingness to adopt a suggestion from whatever quarter it might be advanced." Geol. Trans., vol. v., p. 725.

In February, 1851, the Council of the Geological Society awarded to Professor Sedgwick the Wollaston Palladium Medal, for his original researches in developing the geological structure of the British Isles, the Alps, and the Rhenish Provinces. The President, Sir Charles Lyell, in presenting the medal, said it was impossible to embody, in the brief terms of such a speech, an analysis of his varied labours, but referred especially to his memoirs on the Magnesian Limestone of the North of England, on the Trap-rocks of Durham and Cumberland, on the Fossiliferous strata of the North of Scotland, and on the Isle of Arran; on the Mountains of Cumberland, and the adjoining Lake-district, and of North Wales, his essays on Slaty Cleavage, the determination of the true age of the strata of Devon and Cornwall, which are now termed Devonian; and on the Alps and Rhenish Provinces.

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[1] Mr. Lonsdale had suggested, in December, 1837, that they were intermediate in character between the Silurian and Carboniferous, and therefore of "Old Red Sandstone" age. Proceedings Geol. Soc., vol. v., p. 727.

No member of his University has contributed, in a higher degree than Professor Sedgwick, to elevate its character as a school of the Natural Sciences. To him it is also indebted for much care and liberality in providing for the now large collections of the Geological Museum, the nucleus of which was Dr. Woodward's own small Cabinet.

He has himself contributed to it a noble series of many thousand rock-specimens, chiefly British, and a still more valuable series of organic remains. For the arrangement of the latter, and of all the palæontological collections added to the museum during the last thirty-eight years, he secured first (in 1842–45), the services of the late Mr. J. W. Salter, F.G.S., afterwards palæontologist to the Geological Survey of England and Wales. For the next four years he was assisted by Mr. M'Coy, since appointed to the chair of natural history in the University of Melbourne, Victoria, Australia. Professor M'Coy's descriptive catalogue of the "British Palæozoic Fossils" contained in these collections, has been published by the University, introduced by an elaborate dissertation by Professor Sedgwick, entitled "A Synopsis of the Classification of the British Palæozoic Rocks." In it he has expressed his matured views, and given his final decision on the subject of the classification and nomenclature of the older palæozoic formations, on which he is at issue with his friend and former fellow-worker Sir R. I. Murchison, giving to the Silurian system of that geologist all the lower palæozoic formations above the Coniston grits, and claiming for his own Cambrian system everything, from the Coniston grits inclusive, down to the Skiddaw slate, and its equivalents, the Bangor and Longmynd group, the most ancient of British rocks.

In 1855, the late Mr. Lucas Barrett (afterwards Director of the Geological Survey of the British West Indies) was elected Prof. Sedgwick's assistant and remained until 1859, when he went to Jamaica.

His post as assistant to Prof. Sedgwick has since been filled by Mr. H. G. Seeley, F.G.S. (whose Catalogue on the Reptilian Remains, in the Woodwardian Museum, published under the auspices of Prof. Sedgwick, we noticed in our January number, p. 34).

As a lecturer Prof. Sedgwick's style is clear, earnest, and philosophical, full of energy, and, even now, in his 52nd Course of Lectures, and at the age of 86, he is still vigorous, and, when his health permits, cheerful and full of humorous anecdote. For high moral courage, for hatred of all that is wrong and mean, for generosity of nature and tenderness of heart, Prof. Sedgwick is noted. He is beloved by all who have the pleasure to enjoy his friendship.

In his declining years he has the satisfaction to reflect that he has done several splendid pieces of field-geology, which will ever remain associated with the name of Sedgwick: and, also, that he has been the teacher of many first-rate practical geologists, some of whom, alas! have already done their appointed task, and gone before their master.

The following is a list of Professor Sedgwick's papers, as recorded in Agassiz's "Bibliographia Zoologiæ et Geologiæ," 1854. (Ray Society):—

On the Physical Structure of those formations which are immediately associated with the primitive Ridge of Devonshire and Cornwall.—Trans. Camb i. p. 89.

On the Physical Structure of the Lizard District of Cornwall.— Phil. Soc., i. p. 291.

On the Phenomena connected with some Trap Dykes in Yorkshire a Trans. Cambr. Phil. Soc., ii. p. 21; et Phil. Mag., etc.

On the Association of Trap Rocks with the Mountain Limestone High Teesdale.—Trans. Cambr. Phil. Soc., ii. p. 139, etc.

On the Origin of Alluvial and Diluvial Formations.—*Thomson's* An p. 241; x. p. 18, etc.

On the Classification of the Strata which appear on the Yorkshire C *son's* Ann. Philos., 1826, xi. p. 339, etc.

On some Beds associated with the Magnesian Limestone, and on son found in them.—Proc. Geol. Soc., i. p. 2; Phil. Mag., ser. 2, i. p. 66.

On the Magnesian Limestone of the Northern Counties.—Proc. Geol.

On the Geological Relations and Internal Structure of the Magnes and the Lower Portions of the New Red Sandstone Series in their R Nottinghamshire, Derbyshire, Yorkshire, and Durham, to the Southern Northumberland.—Trans. Geol. Soc. ser. 2, iii. p. 37, etc.

A Syllabus of a Course of Lectures on Geology.—Cambr. 1832 (2nd

Address to the Geological Society, 1830.—Proc. Geol. Soc., i. p. 187 ser. 2, vii. p. 289.

On the General Structure of the Cumbrian Mountains; with a Descripti Dislocations by which they have been separated from the neighbouring Chains.—Trans. Geol. Soc., ser. 2, iv. p. 47, etc.

Address to the Geological Society, 1831.—Proc. Geol. Soc., i. p. 270

On a Series of Longitudinal and Transverse Sections through a Carboniferous Chain between Penigent and Kirkby Stephen.—Trans ser. 2, iv. p. 69, etc.

On the New Red Sandstone Series in the Basin of the Eden, and Coasts of Cumberland and Lancashire.—Trans. Geol. Soc., ser. 2, iv. p

On the Geological Relations of the Stratified and Unstratified Gro composing the Cumbrian Mountains.—Proc. Geol. Soc., i. p. 399, etc.

On certain Fossil Shells overlying the London Clay in the Isle of Sh Geol. Soc., i. p. 409, etc.

On a Band of Transition Limestone, and on the Granite Veins, app Greywacke Slate of Westmoreland, near Shap Fells and Wastdale Geol. Soc., ii. p. 1, etc.

On the Structure of large Mineral Masses, and especially on the Che produced in the Aggregation of Stratified Rocks during different peri Deposition.—Trans. Geol. Soc., ser. 2, iii. p 461, etc.

Notice of an Incursion of the Sea into the Collieries at Workingto Assoc., 1837, Sect. p. 75.

A Synopsis of the English Series of Stratified Rocks, inferior to Sandstone; with an attempt to determine the successive natural Group tions.—Proc. Geol. Soc., ii. p. 675, etc.

Supplement to a Synopsis of the English Series of Stratified Rocks Old Red Sandstone, with Additional Remarks on the Relations of the Series and Old Red Sandstone of the British Isles.—Proc. Geol. Soc., i

On the Geological Structure of North Wales.—Proc. Geol. Soc., iv.

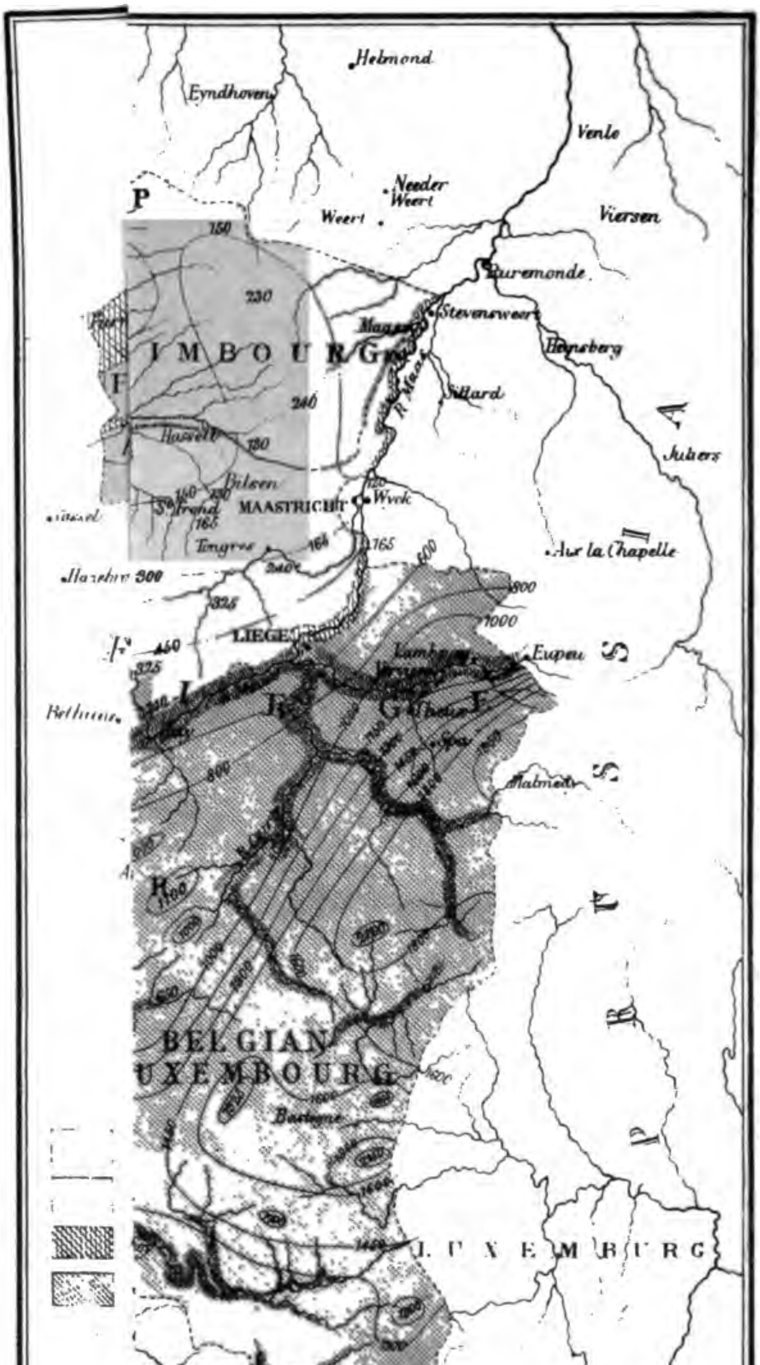
On the older Palæozoic (Protozoic) Rocks of North Wales.— Soc., i. p. 5.

On the Geology of the Neighbourhood of Cambridge, including t between the Chalk Escarpment and the Great Bedford Level.—Rep. 1845. Sect. p. 40.

On the Comparative Classification of the Fossiliferous Strata of with the corresponding Deposits of Cumberland, Westmoreland, and Journ. Geol, Soc., i. p. 442; ii. p. 106.

On the Classification of the Fossiliferous Slates of North Wales, Westmoreland, and Lancashire.—Quart. Geol. Journ., iii. 1, p. 133.

On the Organic Remains found in the Skiddaw Slate, with some Re Classification of the older Rocks of Cumberland and Westmoreland, Geol. Soc., iv. p. 216.



M & N Hanhart, lith.

On the Geological Structure and Relations of the Frontier Chains of Scotland, with a List of Organic Remains by Professor M'Coy.—Rep. Brit. Assoc., 1850, Sect. p. 103. etc.

On the Slate Rocks of Devon and Cornwall.—Journ. Geol. Soc., viii. p. 1.

On the Lower Palæozoic Rocks at the Base of the Carboniferous Chain between Ravenstonedale and Ribblesdale.—Journ. Geol. Soc., viii. p. 35.

On the Classification and Nomenclature of the Lower Palæozoic Rocks of England and Wales.—Quart. Journ. Geol. Soc., viii. p. 136.

Joint papers by Professor Sedgwick and Sir R. I. Murchison.

On the Geological Relations of the Secondary Strata in the Isle of Arran.—Trans. Geol. Soc., ser. 2, iii. p. 21, etc.

On the Structure and Relations of the Deposits contained between the Primary Rocks and the Oolitic Series in the North of Scotland.—Trans. Geol. Soc., ser. 2, iii. p. 125, etc.

On the Structure of the Eastern Alps; with Sections through the newer Formations on the Northern Flanks of the Chain, and through the Tertiary Deposits of Styria, etc.—Trans. Geol. Soc., ser. 2, iii. p. 301, etc.

A Sketch of the Structure of the Austrian Alps.—Proc. Geol. Soc., i. p. 227, etc.

On the Silurian and Cambrian Systems.—Rept. Brit. Assoc., 1835, Sect. p. 59.

Classification of the Old Slate Rocks of North Devon.—Rep. Brit. Assoc., 1836, Sect. p. 95.

On a Raised Beach in Barnstaple or Bideford Bay, on the north-west coast of Devonshire.—Trans. Geol. Soc., ser. 2, v. p. 279, etc.

On the Physical Structure of Devonshire, and on the Subdivisions and Geological Relations of its older Stratified Deposits, etc.—Trans. Geol. Soc., ser. 2, v. p. 633, etc.

On the Classification of the Older Rocks of Devonshire and Cornwall.—Proc. Geol. Soc., iii. p. 121, etc.

On the Distribution and Classification of the Older or Palæozoic Deposits of the North of Germany and Belgium, and their comparison with Formations of the same age in the British Isles.—Trans. Geol. Soc., ser. 2, vi. p. 221, etc.

Joint papers by Professor Sedgwick and W. Peile, Esq.

On the Range of Carboniferous Limestones flanking the Primary Cumbrian Mountains; and on the Coalfields of the North-west Coast of Cumberland, etc.—Proc. Geol. Soc., ii. p. 198.

On the Coalfields on the North-western Coast of Cumberland.—Proc. Geol. Soc., ii. p. 419, etc.

II.—SURFACE-GEOLOGY (Plate V.) OF BELGIUM.

Journal of the Royal Agricultural Society of England. Second series, Vol. vi., Part 1, No. xi., 1870. 8vo. pp. 314. London. John Murray.

WE called attention to Part ii. of the Fifth volume of the Journal of this Society in our December number.[1] We have just received the first part of the sixth volume, and are glad to find that the subject of Agricultural Geology once more finds a place in its pages, and that the Secretary, Mr. Jenkins, is again its advocate and exponent. In the present part, Mr. Jenkins applies his geological training to an exposition of the surface-geology of Belgium, whither he had gone in the latter part of the summer of 1869 to report on the Agriculture of that kingdom, accompanied by Dr. Augustus Voelcker, the Society's chemist.

His report, which occupies 86 pages of the Journal, is illustrated by a chromo-lithographic map, depicting the surface-geology of Belgium, which, by the permission of the Council of the Royal Agricultural Society, we are enabled to reproduce here, for the illustration and better explanation of the few remarks we propose to make thereon.

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[1] See GEOLOGICAL MAGAZINE, 1869, Vol. VI. p. 569.

The accompanying map (Plate V.) conveys to the eye the broad features of the surface-geology of the country, and by the introduction of a series of contour-lines and figures, giving the altitudes, we are enabled to see at a glance the extent of area which each formation occupies, its elevation above the sea, and the coincidence of these lines with the boundaries of the two great superficial deposits, the 'Campine Sands' and the 'Limon de Hesbaye,' which together form two-thirds of the surface of the country. The boundary of the remaining third is sharply defined by the valley of the Meuse, south of which is the plateau-region, mapped as consisting simply of 'strong-land,' the term being used to convey not the geological nature of the tract, but its agricultural character, for we must remember that the map is intended to give a notion of the surface to the farmer. Geologists know, and are reminded by Mr. Jenkins in the text (p. 6), that "the highly contorted beds of limestone or schist belonging to the Carboniferous, Devonian, and Silurian periods," form the solid substrata of this region.

The coincidence of the agricultural and physical characteristics of the author's divisions of the kingdom are described in the following paragraph (p. 2). "In Belgium there are four descriptions of soil, and as many kinds of farming, each soil having a culture peculiar to it. The distribution of the soils is shown on our map by colours, which roughly represent by their hue the relative strength of the land in different regions. Each of these regions is characterised not only by its soil, subsoil, and mode of cultivation, but also by a variation in climate and a difference in the form of its surface, with the exception of the recently formed Polder-land, which has the same climate and surface-configuration as the adjoining districts. We may therefore regard these divisions as natural, and as affording a most interesting example of the dependence of modes of culture on natural attributes."

These divisions are as follows (p. 3) :—"1. The sandy district of Northern Belgium; 2. The loamy district of Central Belgium; 3. The Polders and River-valleys; and 4. The plateau-region of Southern Belgium. The tract of country at the extreme south of Belgium, viz., the Bas Luxembourg, might have been distinguished by another colour; but as its extent is small, and its agriculture has more connexion with that of the Grand Duchy than with the rest of Belgium, besides being of very little importance, we do not propose to notice it as a separate province of agricultural Belgium."

The dependence of the scenery upon the geological structure of these divisions will also be as apparent to our readers, from the following quotations, as will the more agricultural and climatal characteristics, which it is the author's object to bring into relief *(p. 3–4).*

1. *The Sandy District of Northern Belgium.*—To the traveller this region presents the appearance of a dead flat; but in reality it attains, at the extreme eastern boundary of the Campine, beyond Hasselt, an elevation of 250 feet. With the exception of the eastern Campine, however, the maximum elevation is 80 feet, from which height the surface-line gradually descends to the sea-level at the coast. This otherwise perfect inclined plane is interrupted, near its summit, by the wide depressions which form the valleys of the Escaut and its tributaries, and which are so deep, that, although the town of Ghent is only 16 feet above the sea-level, and Termonde is barely 10, the line of 75 feet elevation is not more than six miles distant.

This district comprises the long strip, coloured yellow on our map, and therefore includes nearly the whole of Northern Belgium. It is naturally and almost pure blowing sand which forms the subsoil, and which is known to geologists as the "Campine sands."

With a sandy soil, an abundance of moisture, a sheltered position, and a coast-line washed by a sea warmed by the Gulf-stream, the climate of Northern Belgium is naturally favourable for the practice most characteristic of its agriculture, namely, the growth of two crops in one year. Like the greater portion of England, the kingdom of Belgium lies within the zone of 50° Fahr. mean annual temperature; but neither this nor the mean annual rainfall have much bearing on the agriculture of the countries, for it is the *distribution* of the moisture and the temperature which, as we shall see, really influences differences in agricultural practice. The mean summer temperature and summer rainfall affect the farming to a considerable extent, and the mean winter temperature and winter rainfall have a comparatively slight influence.

2. *The Loamy District of Central Belgium.*—This region, coloured red on the map, is that of the Hesbayan loam, which is covered by a good deep soil of moderate strength, about comparable in most parishes to our best turnip and barley soils, but becoming lighter towards the sandy land of the district just described, and heavier towards those which remain to be noticed. Speaking broadly, the land is of better quality in the central and eastern portions of the district than in the western. Its surface is pleasantly diversified in the west, where it is studded with isolated eminences (see map), the hills attaining a height of between 400 and 500 feet, and becomes simplified in the east, where it forms broad and flat undulations, which are a rolling continuation of the "inclined plane" of Northern Belgium, and rise to a height of nearly 600 feet on the verge of the Meuse valley.

3. *The Polders and River Valleys.*—The soil of this division (ruled blue on the map) consists of what is usually termed alluvium, namely, an argillaceous soil, containing a varying proportion of sand and a little lime. Generally it is extremely fertile, especially when first reclaimed. The term "Polders" is properly applied to alluvial flats, reclaimed from the sea or the mouth of rivers, and protected by dykes against high tides, floods, and storms. The whole

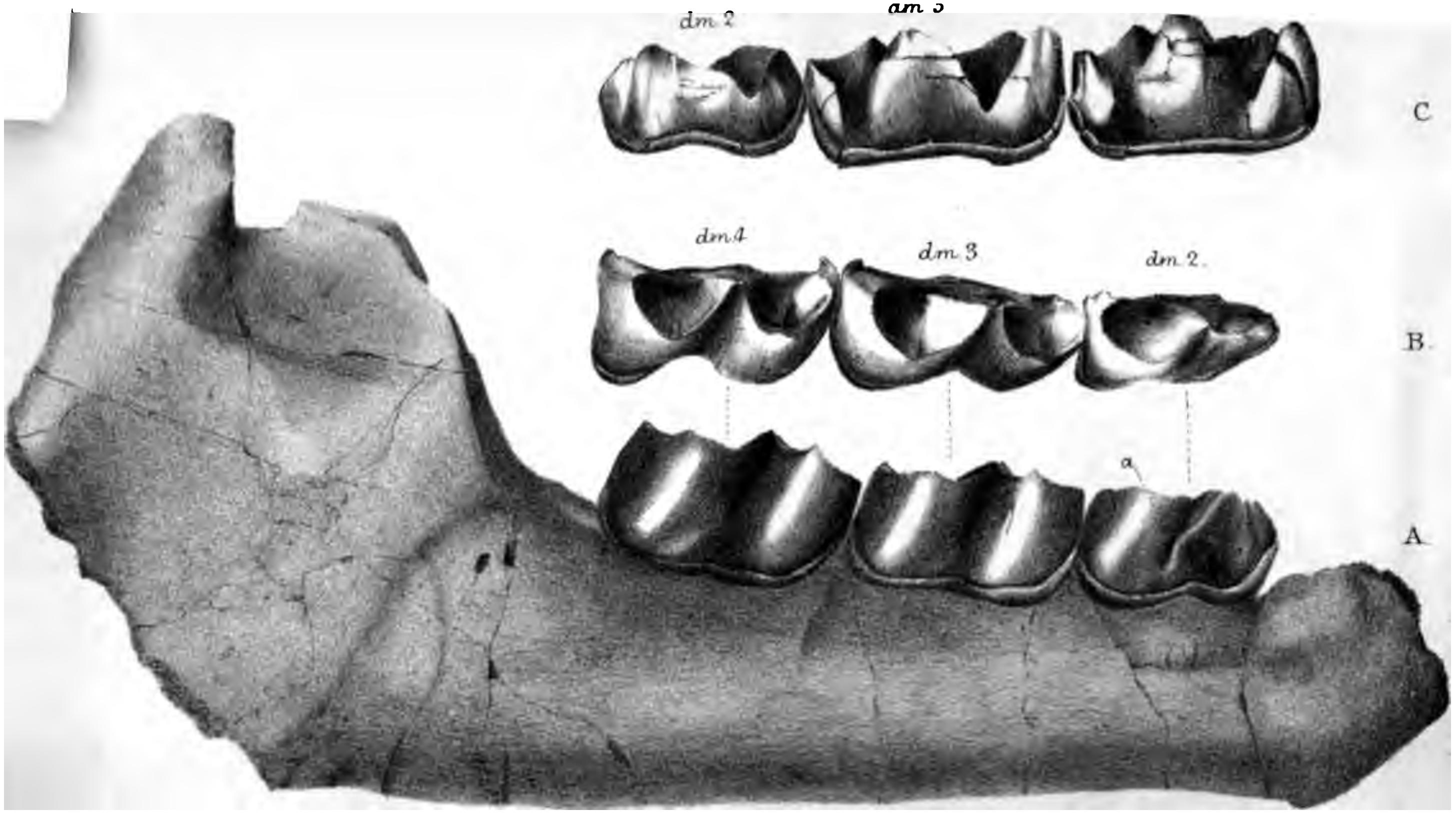
of the Dutch and Belgian coast line consists of this description of land; a large portion of the kingdom of Holland comes under the same title. With this land we have classed the alluvium of the river-valleys, which has been formed by the deposition of mud by the rivers, especially during floods, in those portions of their course where the velocity of the stream is not sufficient to transport the mud brought down from the higher country. Owing to the small scale of the map we have not been able to show these river-deposits, except where they have any great breadth, but in reality they border most of the streams in Northern and Central Belgium. This alluvium differs very slightly from the Polders in actual composition, but very materially in agricultural use; for the former, especially when irrigated, forms extremely rich feeding and meadow land, while the latter is almost exclusively devoted to the growth of corn. In climate the Polder region resembles the adjoining portion of Flanders, differing only to such an extent as may be caused by the influence of the soil on temperature and humidity. Physically the Polders form a nearly plane surface, the undulations being scarcely visible, and rarely attaining a greater height than four or five feet.

4. *The Plateau-region of Southern Belgium.*—A glance at our map will show that south of the Meuse the surface rapidly rises to a height of nearly 800 feet, between which elevation and the line of 1000 feet, it forms a somewhat triangular plateau. Still further south the same phenomena are repeated; the surface rises, even more rapidly than before, from the 1000 feet line to a mean height of about 1500 feet, and then a plateau of more broken character is reached. The former of these mountain-plains is known as the Condroz, and the latter as the Ardennes.

In concluding our notice, we beg to call the attention of geologists to the desirability of adopting, for the superficial deposits of this country, as simple a series of colours as is possible to be used, in order to indicate the different kinds of gravels, sands, clays, etc., which form our Later Tertiary and Quaternary Deposits; so that the farmer, for whose use they are mainly designed, may not be confounded, by their complexity and numbers, in his first attempt to understand the meaning of the colours on the map. This must inevitably happen if the attempt be made to introduce lines, signs, or colours to indicate these superficial deposits upon the already highly coloured geological maps of any area of our Island. A fresh and distinct series of maps is absolutely called for in the interest of the *land-owners* and the farming community generally. Who will undertake the task?

The other point which merits special attention in Mr. Jenkins's map, is the introduction of the contour lines, and the figures indicating the heights above the sea.

We hope this is only the commencement, by the Royal Agricultural Society, of a long series of similar maps and descriptions of English and foreign surface-geology.



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Palæotherium magnum, Cuvier

III.—On the Milk Dentition of *Palæotherium magnum.*

By Professor Huxley, LL.D., F.R.S.

(PLATE VI.)

In the British Museum there is the right ramus of the mandible of a young *Palæotherium magnum*, obtained by M. Bravard from the Eocene strata of Vaucluse, which possesses a peculiar interest, inasmuch as the three principal milk molars are completely cut, though their unworn crowns show that they have not long been in place. The ramus itself must have been nearly eight inches long when it was complete, while the distance from the articular surface of the condyle to the lower margin is about 3·25in. The symphysial surface is oval, rugose, and extends back nearly as far as the anterior margin of the crown of the first visible grinder; the anterior, or mental region of the ramus, is inclined upwards and forwards, and is slightly convex, as in all the true *Palæotheria*. In front of the most anterior milk molar which is in place, there is an oval fossa about 0·2in. long, which appears to lead into the alveolus of the proper first milk molar (dm^1); and further forward (but not more than 0·2in., so that the diastema of the milk teeth must have been exceedingly short) a series of depressions on the truncated anterior end of the ramus represent the bottoms of the alveoli of the canine and incisors.

The ramus of the mandible of an adult *Palæotherium magnum*, in the same collection, can hardly have been less than 15 inches long. The diastema between the small first grinding tooth and the great canine is about 0·8in. long, and the symphysis extends back to a little behind the anterior edge of pm^2.

The three milk molars which are in place (viz., dm^2, dm^3, and dm^4) in the jaw of the young *Palæotherium*, occupy a length of 3·6in., which is identically the same space as that taken up by the second, third, and fourth premolars of the adult jaw.

The length of the crown of		dm^2	; of	pm^2.
	is	1·07in.	„	1·10in.
„ „		dm^3		pm^2.
	„	1·23	„	1·2
„ „		dm^4		pm^4.
	„	1·25	„	1·25

The individual teeth, therefore, correspond in length as nearly as possible.

The height of the crown, measured from the alveolar margin to its highest point, of		dm^2	; of	pm^2.
	is	0·6in.	„	0·9in.
„ „		dm^3		pm^3.
	„	0·8	„	1·0
„ „		dm^4		pm^4.
	„	0·92	„	1·05

Thus the crowns of the grinding teeth of the adult are all not only absolutely higher than those of the young, but, relatively, they are much higher. The vertical striæ on the enamel are also more coarse, and the cingulum which surrounds the whole base of the crown is stronger in the adult.

The patterns of the crowns of the milk molars present the closest resemblance to those of the crowns of the corresponding premolars. The anterior division of the crown of *dm*², however, is more nearly straight than that of the crown of *pm*², so that *dm*² departs more from the bicrescentic pattern than *pm*² does. The sharp backwardly directed ridge (Plate VI., Fig. *A*, *a*) upon the outer face of the anterior division of this tooth, which takes the place of the rounded and convex surface of the anterior crescent of the other teeth, appears to be somewhat more marked in the milk than in the permanent tooth. I can discern no differences of more than individual value between the other milk teeth and those permanent teeth which replace them.

In the adult dentition, the hindermost molar has, as in all other Palæotherian mammals, a strong posterior lobe, with a convex outer and concave inner aspect. It is 0·7in. long, or nearly a third as long as the whole crown, which measures 2·2in.

The milk dentition of the Rhinoceroses and of the Horses is, at one period, in a condition which exactly corresponds with that of *Palæotherium magnum*. That is to say, the three posterior milk molars, *dm*², *dm*³, *dm*⁴, are in place and ready for use, while *dm*¹ remains in its alveolus, and is only cut very much later.

The foal differs from the young *Palæotherium* in the length of the crown of *dm*², which is as great as, if not greater than, that of the crowns of the other two milk molars; in the greater distance of the alveolus of *dm*¹ from *dm*², and in the much greater length of the diastema.

In the Rhinoceroses on the other hand (e.g. *Rh. indicus*) *dm*² is smaller in proportion to *dm*³ than in the *Palæotherium*, and, if there were a canine tooth, the diastema would be as short as in the latter.

In the form of the ramus the Horse lies between the *Palæotherium* and the Rhinoceros.

It follows, from what has been stated, the rule which has been laid down for the *Ungulata* in general, that the crown of the last milk molar in the lower jaw always remembles that of the last true molar, does not hold good for *Palæotherium*. The genus *Paloplotherium* was founded upon the supposition that it did, and Pictet in the following passage very properly bases the distinctness of *Paloplotherium* from *Plagiolophus*, only on the ground that *Paloplotherium* is asserted to have no third lobe to its posterior lower molar.

Il resulté de là :—1. Que le *P. minus* et le *P. annectens* se ressemblent par tout l'ensemble de leur dentition, et qu'ils different par plusieurs points essentiels des vrais *Palæotherium*.

2. Qu'ils se distinguent cependant l'un de l'autre par la forme de la dernière molaire inférieure, que est à trois collines dans le premier et à deux dans le dernier.

3. Que le *P. annectens* doit en consequence former un sous genre spécial qui conserverait le nom de *Paloplotherium*, donné par M. *Owen, et* que le *P. minus* est le type d'un autre sous genre très

voisin, mais distinct, auquel doit être attribué le nom de *Plagiolophus*, Pomel.[1]

The first volume of Pictet's "Paléontologie" was published in 1853. The "Memoire" from which the extract just quoted is given, appeared in 1855; so that if M. Pictet rectified the character of *Paloplotherium* in the former year, he rectified his rectification in the latter.

As the originator of the error by which Pictet was misled now admits (what was very well known before) that the genus *Paloplotherium* was founded upon a mistake,[2] of course it disappears from zoological nomenclature, unless, indeed, it be retained for M. Gaudy's *P. codiciense*, which is very different from *Plagiolophus*.

March, 21, 1870.

EXPLANATION OF PLATE VI.

The right ramus of the mandible of a young *Palæotherium magnum*, of the natural size, with three milk molars. From the Eocene of Vaucluse.

A. Viewed from the outer side.
B. The crown of the teeth seen from above.
C. Viewed from the inner side.

IV.—NOTES ON THE TERTIARY ENTOMOSTRACA OF ENGLAND.

By Prof. T. RUPERT JONES, F.G.S., of the Royal Military College, Sandhurst.

IN the February number of the GEOLOGICAL MAGAZINE is a revised list of the Cretaceous Entomostraca, described and figured in my Pal. Soc. Monograph of 1849; and I now propose to offer a revision of the Tertiary Entomostraca published in my Pal. Soc. Monograph of 1856. The general observations on the subject offered in February will hold good in this instance also. A corrected list of the generic and specific names is appended; and to this the numbers in the following notes refer.

No. 1. Mr. G. S. Brady has pointed out (Monogr. Recent Brit. Ostrac., Trans. Linn. Soc., vol. xxvi., 1868, p. 382) that this must be the same as *Candona compressa*, Koch, sp.

No. 3. Mr. Brady (*op. cit.* p. 374) refers this to Müller's *Cypris lævis*.

No. 5. This is a *Cypris* according to Mr. Brady (*op. cit.* p. 370).

Nos. 6 and 7. These were referred to *Candona*, on account of their general agreement in shape and *lucid spots* with the foregoing (No. 5); but, like it, they may really belong to *Cypris*.

No. 9. Mr. Brady finds this living in the British Seas (*op. cit.* p. 408).

No. 10. Mr. Brady has taken great trouble with this species. He believes it to be a true *Cytheridea;* and he regards the smooth form (Monogr. Tert. Entom. pl. 2, fig. 1*e*) as belonging to a different species (*C. littoralis*). There has been much confusion in the nomenclature of this species, which, with some allies, has been found in several localities; but Mr. Brady has done much to clear up the difficulties ("On the Crustacean Fauna of the Salt-marshes," etc., Nat. Hist. Trans. Northumb. and Durham, 1868, p. 7). Mr. Brady has detected *C. lacustris* (Sars) also among the specimens from Grays.

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[1] Mémoire sur les Animaux Vertébrés trouvés dans le Terrain siderilitique du canton de Vaud (p. 36).

[2] See the last number of the GEOLOGICAL MAGAZINE, p. 143.

No. 11. Owing to the poorness of the published figures of the German specimens, my friend Mr. Brady is unwilling to accept Münster's appellation for the *Cythere* represented by me under this name of "*punctata*," and refers it (*op. cit.* p. 401) to *Cythere convexa*, Baird. For my part, however, I think we shall not err in retaining the old name. *Cypridina punctatella*, Rss. (*Cythere punctatella*, Bosq.), referred to in the synonomy at p. 24 of my Monograph, belongs to *Loxoconcha*, according to Mr. Brady.

No. 13 is doubtless a *Cytheropteron*, Sars (Brady, *op. cit.* p. 447).

No. 14. This has the hinge-characters of *Loxoconcha*. It is from the Headon series (Upper Eocene Series) of Colwell Bay.

No. 17. This has the shape of a *Cytherura*, Sars (Brady, *op. cit.* p. 439).

No. 18. The doubt with which this was referred to Reus's *C. Kostelensis* was confirmed when a better figure of that species was published by Egger. I propose to call the Woolwich specimen *C. amissa*. Its generic relationship is doubtful.

No. 21. Brady's *Cythere mutabilis* (Trans. Zool. Soc., 1866, p. 377, pl. 59, fig. 14), a British recent form, is near to this.

No. 23. My name for this cannot stand, as another and somewhat similar species has been so called by Reuss. I propose *sublacunosa* as a fitting name for the Suffolk species; indeed, this was the term intended, as I find by my old notes. This form has many allies; for instance, some recent Norwegian specimens are mentioned in my Monograph (p. 31) as being of the same species; and these have been referred by Mr. Brady (who at first thought them to be varieties of Reuss's *C. clathrata* and *C. lyrata*, and Speyer's *C. latimarginata*) to Sars' *C. angulata, abyssicola*, and *tuberculata* (*op. cit.* pp. 406, 409, and letters).

No. 26. *C. plicata* is found abundantly in the Upper Eocene of Colwell Bay; and its variety *laticosta* is plentiful in the Middle Eocene of Barton and Highcliff.

No. 28 is from the Upper Eocene of the Isle of Wight.

No. 30. *C. limicola*, Sars (Brady, *op. cit.* p. 405) is the recent Norwegian representative of *C. trachypora*, referred to in my Monograph, p. 36.

No. 31. Brady's *Cythere emaciata* (*op. cit.* p. 414), from the British Coasts, is a close ally of this form.

No. 32. Near to this is *C. bicostulata*, Speyer (Ostrac. Cassel. Tert. 1863, p. 27, pl. 3, fig. 6); but it has the more pronounced features of a stronger form.

No. 36. Mr. Brady (*op. cit.* p. 418) merges this in the recent British species, *C. Jonesii*, of Baird, published about the same time as Bosquet's Memoir.

No. 37 is from the Upper Eocene of the Isle of Wight, and the Middle Eocene of Bracklesham.

No. 41. This has been found living in the North-British seas by Mr. Brady, *op. cit.* p. 428.

No. 42. This species is noted above, p. 74, No. 1. There are several forms of this kind, besides the two varieties, *insignis* and *glabra*, from the London Clay (Monograph, p. 46); such as *C. punctatella*, Bornemann, Zeitsch. vii. (1855), p. 360, pl. 21, fig. 2, and *C. incrassata*, Bosq., Ent. Tert., p. 44, pl. 3, fig. 11.

No. 45. This is a doubtful species. It may be the young of the next.

No. 46. This curious species, or one extremely like it, has turned up in specimens given to me by the late Dr. Mantell, as coming from the Oxford Clay of Wiltshire, and also in the Oxford Clay of Skye, collected by Messrs. Geikie and Young, and there associated with *Estheria*. Its generic characters are doubtful. If its freshwater habitat in the Hempstead series be a criterion, it points to more freshwater or estuarine conditions in the Oxfordian series than are usually thought of.

No. 47. This has been found recent in the Atlantic at many places by Mr. Brady (*op. cit.* p. 435), and proves to be a *Loxoconcha*, Sars.

No. 48. This may be a *Cythere;* it is not a true *Cytherideis.*

No. 49. This is a living Atlantic species, and Mr. Brady (*op. cit.* p. 432) refers it to *Ilyobates*, Sars.

No. 50. According to Mr. Brady, Müller's *C. flavida*, differs materially from this kind of form. Nor will the Crag species suit with *Cytherideis subulata*, Brady, which is represented (*op. cit.* p. 454, pl. 35, fig. 43–46) as the species termed *C. flavida* by Dr. Baird. I therefore propose a new name (*C. lotellina*) for the Crag species, referring it to *Cythere*. The references to Recent and Upper Eocene specimens, at p. 50 of the Monograph, will not hold good.

No. 51. The genus is not well substantiated.

No. 52. Mr. Brady has suggested that we have not the real *B. subdeltoidea* in the forms figured in the Monograph; and it is quite possible that he is right. The Crag form, pl. 4, figs. 2 and 3, is very much like his *B. fusca* (Trans. Zool. Soc. 1866, p. 364, pl. 57, fig. 9), from Australia; and the specimens from the London Clay, pl. 6, figs. 1 and 2, are like his *B. formosa* (Ann. Nat. Hist. ser. 4, vol. ii., p. 221, pl. 14, figs. 5–7) from Tenedos; but still more closely correspond with *subtrigona*, Bornemann (Zeitsch. Geol. Ges. vol vii., p. 357, pl. 20, fig. 4), from the Oligocene Septarium-clay of Hermsdorf.

No. 54. Described as *Cytherella compressa* and varieties. These may either belong to that species, or be separate species, namely *C. fabacea*, *Beyrichii* (Rss.), and *intermedia* of Bornemann. Figs. 21 and 23 fairly correspond with his figure of *C. fabacea*; fig. 18 is decidedly *C. Beyrichii* (Rss. sp.); and fig. 19 has a strong resemblance to his *C. intermedia*, and Brady's *C. Scotica* (*op. cit.* p. 473, pl. 34, figs. 18–21) is very near it. The *Cytherellæ* require synoptical revision and perfect figuring of all their varieties. The species seem to have considerable variations.

No. 56. Fig. 12 may be separated as var. *rectipunctata.*

The following is a corrected list of the Tertiary Bivalved Entomostraca of England:—

	OLD NAMES.	NAMES NOW ADOPTED.
1.	*Cypris setigera*, Jones.	*Candona compressa*, Koch, sp.
2.*	,, ,, var. *tumida*.	*Cypris Browniana*, Jones.
2.	,, *Browniana*, Jones.	,, ,, var. *tumida*.
3.	,, *ovum*, Jurine.	,, *lævis*, Müller.
4.	,, *gibba*, Ramdohr.	,, *gibba*, Ramd.
5.	*Candona reptans*, Baird.	,, *reptans*, Baird, sp.
6.	,, *Forbesii*, Jones.	*Candona* ? *Forbesii*, Jones.
7.	,, *Richardsoni*, Jones.	,, ? *Richardsoni*, Jones.
8.	,, *candida*, Müller, sp.	,, *candida*, Müller, sp.
9.	,, ? *subæqualis*, Jones.	,, ? *subæqualis*, Jones.
10.	*Cyprideis torosa*, Jones.	*Cytheridea torosa*, Jones, sp.; and *Cytheridea littoralis*(?), Brady.
11.	*Cythere punctata*, Münster.	*Cythere punctata*, Münster.
12.	,, *trigonula*, Jones.	,, *trigonula*, Jones.
13.	,, *triangularis*, Jones.	*Cytheropteron triangulare*, Jones.
14.	,, *Wetherellii*, Jones.	*Loxoconcha Wetherellii*, Jones.
15.	,, *striatopunctata*, Rœmer, sp.	*Cythere striatopunctata*, Rœmer, sp.
16.	,, *consobrina*, Jones.	,, *consobrina*, Jones.
17.	,, *attenuata*, Jones.	*Cytherura attenuata*, Jones.
18.	,, *Kostelensis*(?), Reuss, sp.	*Cythere* ? *amissa*, Jones (1870).[1]
19.	,, *concinna*, Jones.	*Cythere concinna*, Jones.
20.	,, *Woodiana*, Jones.	,, *Woodiana*, Jones.
21.	,, *laqueata*, Jones.	,, *laqueata*, Jones.
22.	,, *dictyosigma*, Jones.	,, *dictyosigma*, Jones.
23.	,, *lacunosa*, Jones.	,, *sublacunosa*, Jones (1870).
24.	,, *scabropapulosa*, Jones.	,, *scabropapulosa*, Jones.
25.	,, *costellata*, Rœmer, sp.	,, *costellata*, Rœmer, sp.
26.	,, *plicata*, Münster.	,, *plicata*, Münster.
26.*	,, ,, var. *laticosta*.	,, ,, var. *laticosta*.
27.	,, *scrobiculoplicata*, Jones.	,, *scrobiculoplicata*, Jones.
27.*	,, ,, var. *recta*.	,, ,, var. *recta*.
28.	,, *angulatopora*, Reuss, sp.	,, *angulatopora*, Reuss, sp.
29.	,, *macropora*, Bosquet.	,, *macropora*, Bosquet.
30.	,, *trachypora*, Jones.	,, *trachypora*, Jones.
31.	,, *retifastigata*, Jones.	,, *retifastigata*, Jones.
32.	,, *sphærulolineata*, Jones.	,, *sphærulolineata*, Jones.
33.	*Cythereis senilis*, Jones.	,, *senilis*, Jones.
34.	,, *Bowerbankiana*, Jones.	,, *Bowerbankiana*, Jones.
35.	,, *horrescens*, Bosquet, sp.	,, *horrescens*, Bosquet.
36.	,, *ceratoptera*, Bosquet, sp.	,, *ceratoptera*, Bosquet.
37.	,, *cornuta*, Rœmer, sp.	,, *cornuta*, Rœmer, sp.
38.	*Cytheridea Muelleri*, Münster, sp.	*Cytheridea Muelleri*, Münster, sp.
38.*	,, ,, var. *intermedia*.	,, ,, var. *intermedia*.
38.**	,, ,, var. *torosa*.	,, ,, var. *torosa*.
39.	,, *debilis*, Jones.	,, *debilis*, Jones.
40.	,, *pinguis*, Jones.	,, *pinguis*, Jones.
41.	,, *Sorbyana*, Jones.	,, *Sorbyana*, Jones.
42.	,, *perforata*, Rœmer, sp.	,, *perforata*, Rœmer, sp.
42.*	,, ,, var. *insignis*.	,, ,, var. *insignis*.
42.**	,, ,, var. *glabra*.	,, ,, var. *glabra*.
43.	*Cytherideis trigonalis*, Jones.	*Cytherideis trigonalis*, Jones.
43.*	,, ,, var. *lævis*.	,, ,, var. *lævis*.
44.	,, *tuberculata*, Jones.	,, *tuberculata*, Jones.
45.	,, *unisulcata*, Jones.	,, ? *unisulcata*, Jones.

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[1] The date "1869" appended to the new names in the Table at pages 76 and 7 should be corrected to "1870," as the paper was printed in this year, thoug written some months ago.

OLD NAMES.	NAMES NOW ADOPTED.
ytherideis unicornis, Jones.	*Cytherideis ? unicornis*, Jones.
,, *tamarindus*, Jones.	*Loxoconcha tamarindus*, Jones, sp.
,, *Colwellensis*, Jones.	*Cythere ? Colwellensis*, Jones.
,, *Bartonensis*, Jones.	*Ilyobates Bartonensis*, Jones, sp.
,, *flavida*, Müller, sp.	*Cythere botellina*, Jones, (1870).
,, *ren*, Jones.	*Cytherideis ? ren*, Jones.
airdia subdeltoidea, Munster, sp.	*Bairdia fusca*(?), Brady: and *B. subtrigona*, Bornemann.
,, *contracta*, Jones.	*Bairdia contracta*, Jones.
ytherella compressa, Münster, sp.	*Cytherella compressa*, Münster, sp.
,, ,, var. *Beyrichii*.	,, *Beyrichii*, Reuss, sp.
,, ,, var. *intermedia*.	,, *intermedia*, Bornemann.
,, *Londiniensis*, Jones.	,, *Londiniensis*, Jones.
,, *Muensteri*, Rœmer, sp.	,, *Muensteri*, Rœmer, sp.; and var. *rectipunctata*, Jones (1870).

.—ON THE BASALTIC ROCKS OF THE MIDLAND COAL-FIELDS.

By SAMUEL ALLPORT, F.G.S.

the GEOLOGICAL MAGAZINE for March last, Vol. VI., p. 115, I gave a short account of the discovery of Olivine and its pseudophs in the igneous rocks of the South Staffordshire Coal-field, as I have since then made a microscopical examination of ilar rocks from the surrounding district, I am induced to offer following observations.

t has been long known that igneous rocks occur in the Coalls of the Midland Counties; they have been called "Basalts" and reenstones" by the officers of the Geological Survey, but as no ount has hitherto been given of their mineralogical composition, as been uncertain whether they should be referred to the augitic ornblendic groups, or if they differed from each other in this rect. On referring to the maps of the Survey it will be seen that ntinuous belt of Coal-measures extends for about 30 miles in a therly direction, from the Abberly Hills in the south, as far as leshall Hill, seven miles north-east of Wellington.

he southern portion forms the Forest of Wyre Coal-field, and the thern the Shropshire Coal-field. In the map containing the mer there is a mass of so-called "Greenstone" at Kinlet, and ther long band at Shatterford; also a mass of "basalt" capping a t of the Clee Hills. In the northern part of the district there are wn several masses of "basalt" in the Carboniferous rocks, lying ween Wellington and Coalbrookdale. The mass marked "Greenne," forming the ridge of the Wrekin, together with the larger ss to the north-west, belong to a totally different class of rocks. e other localities from which I have collected specimens, are the hitwick Colliery, near Coalville, in Leicestershire, and the neighrhood of Matlock, in Derbyshire.

A microscopical examination of thin sections, made from carefully ected specimens, clearly shows that all the above rocks belong to e same species; they do not in fact differ more from each other n different portions of any one of them, all being composed of the following constituent minerals—Triclinic felspar, probably Labradorite (but which has not been positively determined), Augite, Titano-ferrite, or magnetic oxide of iron, Olivine, and, very generally, long hexagonal crystals of Apatite.

In addition to these, the following minerals occur more or less frequently, as secondary formations filling cavities; Calcite, a brown Zeolite, and a green chloritic mineral; the latter sometimes filling, at others merely lining, the minute cavities, the central portion in this case being Calcite.

The felspar usually occurs in rather long prisms, showing the characteristic striæ when viewed by polarised light; the augite is frequently well crystallized, and contains many glass-cavities; the iron oxide occurs in minute grains, or as thin plates; and the Olivine as crystals or irregular grains. As stated in my previous communication, the Olivine almost invariably occurs as a pseudomorph; there is, however, no difficulty in detecting it, as it frequently retains the characteristic crystalline form, and, even when in irregular grains, the peculiar veined appearance, and irregular play of colours when examined by polarized light, are decisive as to its character. I have, however, been again successful in finding specimens containing the mineral in various stages of alteration.

In South Staffordshire the igneous rocks present two varieties; one is a hard greyish-black basaltic rock, with a conchoidal fracture, sometimes perfectly columnar, as at Pouk Hill, near Walsall; the other is locally known as "Green rock," and differs only from the former in that it contains a larger proportion of a green chloritic mineral, which is evidently a secondary formation. It is a clear green when fresh broken, but turns blackish on exposure. This "Green rock" occurs in sheets between the Coal-measures, and has undergone a greater amount of alteration than the more massive portions of the rock; usually it is not so hard, and Carbonate of Lime and Zeolites are more frequent.

The rock from Coalville presents precisely the same characters, and is especially interesting, as it contains Olivine in different stages of alteration. In this locality the basalt lies on the upper seam of coal, which is said to be altered; it is itself covered by undisturbed and unaltered new Red Sandstone.

The mass of "Basalt" at Little Wenlock, three miles south of Wellington, is also precisely of the same character; a thin section shows several pseudomorphs after Olivine, in some of which the change is not complete; and also examples of the chloritic mineral filling up spaces between the crystals of felspar and augite.

The rock in Arley Wood near Shatterford is a fine grained black basaltic rock, a section of which contains a perfectly-formed crystal of altered Olivine.

The "Basalt" capping the Titterstone Clee Hill, contains Olivine nearly unaltered, and well formed crystals of Augite. This rock is quite undistinguishable from specimens from Rowley.

The well-known Toadstone of Derbyshire is an amygdaloidal variety of the same kind of rock; it is regularly interbedded with the

Carboniferous Limestone, and was evidently a contemporaneous lava-stream, partly scoriaceous, and partly of a compact basaltic structure. Generally the cavities have been filled with carbonate of lime or other minerals, thus forming an amygdaloid; other specimens, however, have empty cavities, and are as vesicular as recent lavas. A specimen taken from the tunnel through the High Tor at Matlock, is quite undistinguishable from the Staffordshire rocks, and contains a considerable proportion of Olivine.

With respect to the precise age of these rocks, there is no satisfactory positive evidence, except in Derbyshire, where they clearly alternate with the Carboniferous Limestone, but there is a considerable amount of negative evidence to show that all are probably contemporaneous with the Coal-measures as *a whole.*

In South Staffordshire the "Green Rock" runs very regularly for considerable distances between the same seams of coal or shale, but occasionally penetrates higher beds, or, may be, has descended from higher to lower. In such cases the rock is clearly intrusive, but the disturbance is confined to a portion only of the Coal-measures, and in some pits the singular intermixture of coal or shale with the trap, at once suggests the idea that the igneous matter was intruded before the consolidation of the beds. No igneous rock has yet been found in the lowest beds of coal or ironstone, or in the underlying Upper Silurian Rocks. In other words, there is no evidence to show that it has been intruded from below in *this district,* nor am I aware of any which proves it to have been injected subsequently to the completion of the entire Carboniferous series.

As the small Coal-fields of the district are surrounded on all sides by rocks, of Permian or Triassic Age, in which no intrusive rocks are to be found, there can be no reasonable doubt that the basaltic rocks now described are at least Ante-permian, and that probably they belong to the Carboniferous period itself. That it was a period of great igneous activity is certain, from the facts so well brought out by Mr. Giekie and other Scottish geologists, and as there is now no doubt as to the identity in composition of all these rocks, the greater part of them may well have been derived from the same source, for the now detached Coal-fields are probably but the fragments of one of far greater extent.

It will be seen, from the description now given, that these rocks correspond in every respect to those known by the various names of Trap, Basalt, Anamesite, Dolerite, Melaphyr; the term basalt is, however, now restricted by some to rocks of Tertiary or Recent age; a distinction, I think, to be deprecated, as no sharp line can be drawn between Tertiary and Pre-tertiary rocks. There is evidently no other difference between the Tertiary and the older basaltic rocks than that produced by the subjection of the latter, during enormous periods of time, to the chemical action of water holding various substances in solution, and modified in many cases by heat and pressure. In this respect, the occurrence of Olivine and its pseudomorphs is especially interesting, for, till quite recently, this mineral has been regarded as characteristic of the younger basalts: we have seen, however, that it is present as a constituent of the older rocks, and its generally altered state is one of several proofs of the chemical and molecular changes which have been produced.

Whether these rocks should be called Basalt, Dolerite, or Melaphyr, I leave others to decide; but would again repeat, that we shall have no satisfactory nomenclature, or classification of rocks, till the microscope is as much used by petrologists as it has long been by workers in every other branch of Natural History.

In the Warwickshire Coal-field igneous rocks also occur in the lower beds of the series; they differ considerably, however, from those now described, and require a separate notice.

VI.—NOTE ON THE MIDDLE DRIFT-BEDS IN CHESHIRE.

By J. E. TAYLOR, F.G.S.

THE valuable paper by Professor Harkness on the Middle Drift deposits of Great Britain does not include a notice of their occurrence in Cheshire. About six years ago, a paper of mine on this subject was published in the Reports of the Geological Society of Manchester. I revert to it again, inasmuch as the only locality little dwelt on by Professor Harkness bears out so thoroughly the chief peculiarity about the beds in question.

The great flat plain, in the centre of which stands the populous and industrious town of Crewe, is underlain by sands and gravels of Middle Drift age. The higher portions of the knolls (they cannot be called hills) are generally capped by a fine Boulder-clay. There are few sections exposed in the neighbourhood of Crewe, but when I lived in that neighbourhood several wells were dug, of which I kept a careful account. Before giving an account of one of the principal of these well-borings, let me notice the great abundance of *Chalk flints* in the gravels. These are so great that pits are opened in many places for road-mending purposes. At Barthomley, about three miles to the south-east of Crewe, there are several of these pits, each characterized by the abundance of genuine flints, although Chalk strata are so far removed. In the paper above mentioned I suggested that the origin of these flints might be the Irish Chalk. In most cases they are well rounded, except where local fracture has split them up.

The following is a list of beds passed through in the sinking of a well for cottage purposes. The thinness of some of the beds is indicative of their shallow-water origin, as well as perhaps of their local extension. But as this is a feature in the Middle Drift sands, as far as I have been an observer, it is not worth while to state more than that I believe the following to be a good typical section of the Cheshire sands:—

	FEET.
Sand (current-bedded)	21
Fine Gravel (with shells)	3
Ochreous Sand	8
Shelly Gravel	3
Fine Clay	8
Stiff Clay, with pebbles and shells	30
Brick Earth	8
Total	76

The layer of fine gravel beneath the false-bedded sand was astonishingly rich in shells, most of which were fragmentary. Scarcely a handful could be taken up without observing them. Amongst them I identified the following:—*Cardium edule* (abundant), *Tellina, Mactra, Mytilus, Buccinum undatum,* and *Turritella terebra.* The stiff clay with pebbles was scarcely less rich in shelly fragments; only here the univalves were rare. It will be seen that these species are those commonly found in the Middle Drift sands, and the occurrence of chalk flints in such abundance, so far away from an outcrop of chalk strata, indicates some long-continued and general action.

VII.—Geology of the Line of the Great Pacific Railroad.

THE following interesting communication relating to this wonderful line of Railway (forming part of a letter from F. B. Meek, Esq., of the Geological Survey of Illinois, U.S.A., to Dr. J. J. Bigsby, F.R.S., author of the *Thesaurus Siluricus*), has been forwarded to us for insertion by the kindness of Dr. Bigsby.

"In regard to items of Devonian Palæontology, it so happens that I have, just at this time, a few facts that may be of some interest to you. Mr. Clerence King, who has charge of a Government Geological Survey along the line of the Pacific Railroad, through from the Pacific, has submitted to me his whole collection of fossils for examination. As the party was in the field nearly three years, the collection is large, and includes fossils from various formations. Consequently I am only aiming, at first, to go over the whole in a *general* way, merely to determine the age of the rocks at various localities, after which I expect to give them a more thorough study. He has Devonian fossils from several localities a little east of Central Nevada. From his collections, obtained in the White Pine mining district, I have been able to determine that the great Silver-bearing rock of those mines belongs to the Devonian; though the Carboniferous is also well developed there. As these are very rich mines, that are yielding *tons* of silver, I have considered it a matter of some interest to determine the age of the rock. The specimens being mostly imbedded in the matrix, require some time and patience in order to work them out; and more critical comparisons than I have yet been able to give them, before I can speak *positively* in regard to all of the species. I can, however, give you, without doubt, the names of nearly all the genera, and of some of the species. They are as follows:—

"Corals and Polyzoa. — *Diphyphyllum, Syringopora, Smithia Hennahii* (Lonsdale), and *Acervularia pentagona* (Goldf.), or very closely allied forms. *Chonophyllum,* very similar to *C. perfoliatum* (Goldf.), *Favosites, Alveolites,* and *Retepora.*

Mollusca.—*Productus* (small, like *P. subaculeatus*), *Rhynchonella, Atrypa reticularis* (Linn.), Spirifer *Utahensis* (Meek),[1] *Spirifer Engel-*

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[1] I originally described this under another name (*S. Norwoodi*), but on finding it pre-occupied, I afterwards changed it to Utahensis. [See Proceed. Philad. Acad., July, 1860, p. 308.]

manni (Meek), *Macrocheilus*, *Pleurotomaria*, and two species of *Orthoceras*.

I had, in 1860, referred this rock to the Devonian, on the evidence of some of these same fossils (and the absence of any Silurian or Carb. types), brought in, by Col. Simpson's Exploring Expedition, from another locality a little farther north, though at that time this rock was not known to be a silver-bearing formation.

In addition to several of the above-mentioned fossils, I had from this rock, in 1860, fragments of *Phacops*, *Homalonotus*, and of another fossil, I thought might be a *Calymene*, but I do not think now that it could have belonged to that genus.

It is highly probable that the silver-veins of this region come up from the Silurian, but no lower rocks than the Devonian have yet been found just there.

At other localities, farther east in Nevada, Mr. King found *Atrypa reticularis*, a *Spirifer*, and a *Dalmanites*, evidently Devonian types, and apparently from about the horizon of the Corniferous or Onondaga limestone of the N. Y. series.

From other localities he has *Ophileta complanata*, Vanuxem, and two species of those many-whorled depressed shells, often referred to *Euomphalus*, from a low position in the Silurian; also Primordial Trilobites. In West Humboldt range of mountains he obtained a fine collection from the Upper Trias, that afforded some of the same types figured in the California Report. These are as clearly of the age of the St. Cassian, as if the words "St. Cassian" were printed in Roman letters on every specimen. He also has Cretaceous and Tertiary Fossils. All the Tertiary yet known from this great internal region of the Continent, is of fresh or brackish-water origin. The Tertiary rests conformably on the Cretaceous, and the passage from one to the other seems to have been coincident with the change from marine to brackish-water deposits, which were afterwards succeeded by fresh-water formations."

"The information given herein was kindly permitted to be sent by Mr. Clerence King, Director of the Government Geological Survey along the line of the Pacific Railroad."—F. B. MEEK.

NOTICES OF MEMOIRS.

I.—ON THE SUBMERGED FOREST AT BLACKPOOL, NEAR DARTMOUTH, SOUTH DEVON. By W. PENGELLY, F.R.S., F.G.S.[1]

IN a paper on the Submerged Forests of Torbay,[2] which I had the pleasure of reading to this Association, during the meeting at Tiverton, in 1865, I recorded the facts that a Submerged Forest existed at Blackpool, about two and a half miles south-west of Dartmouth; that it was almost always entirely concealed by the sand thrown up by the waves; that it had been described to me by persons who saw it during two brief exposures, one in July, 1802, and the other about fifty years afterwards; and that there was reason to believe that it had never been laid bare during the interval; so that two generations of geologists might have traversed the strand at every low water without detecting a trace of the forest beneath them.[1]

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[1] Transactions of the Devonshire Association for the Advancement of Science, Literature, and Art. 1869.

[2] Ibid. vol. i. pp. 30–42.

The *Torquay Directory* of February 10, 1869, contained the following paragraph:—"The fine beach, situate about midway between Stokefleming and the far-famed Slapton Ley, just now presents a most unusual appearance. The action of the heavy seas during the late tempestuous weather has entirely removed the deep bed of sand from the western end, exposing a bottom of blue clay, in which, at low water, portions of bark and nuts may be found embedded, which indicate the remains of a primeval forest, which, ages ago, flourished on the spot. The place is well worthy a visit from any one interested in geological incidents."

From the description of the locality, it was tolerably certain that the forest alluded to was that at Blackpool. Believing that a shift of wind would cause the waves to restore the sand, and once more to bury this interesting but rarely-seen evidence of a change of relative level of land and sea, I started for Dartmouth the next day, February 11th, accompanied by three ladies who take a lively interest in geological phenomena. On reaching Dartmouth we found, as had been expected, that our destination was Blackpool, and that the forest was still to be seen.

We were so fortunate as to reach the beach at spring tide low water, and to find, admirably exposed, by far the finest example of a Submerged Forest which I have ever seen. It occupied a rectangular area, extending from the small river or stream at the western end of the inlet, about one furlong eastward; and from the low-water line, thirty yards up the strand.

The lower or seaward portion of the forest area, occupying about two-thirds of its entire breadth, consisted of a brownish drab-coloured clay, which was crowded with vegetable débris, such as small twigs, leaves, and nuts. There were also numerous prostrate trunks and branches of trees, lying partly embedded in the clay, without anything like a prevalent direction. The trunks varied from six inches to upwards of two feet in diameter. Much of the wood was found to have a reddish or bright pink hue, when fresh surfaces were exposed. Some of it, as well as many of the twigs, had almost become a sort of ligneous pulp, whilst other examples were firm, and gave a sharp crackling sound on being broken. Several large stumps projected above the clay in a vertical direction, and sent roots and rootlets into the soil in all directions and to considerable distances. It was obvious that the movement by which the submergence was effected had been so uniform as not to destroy the approximate horizontality of the old forest ground. One fine example was noted of a large prostrate trunk having its roots still attached, some of them sticking up above the clay, whilst others were buried in it. This tree had fallen towards the east.

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[1] Transactions of the Devonshire Association, p. 32.

Both the trunks and the soil, though carefully examined, failed to disclose any traces or indications of ancient tools. Nor was the search for bones, teeth, antlers, or, indeed, animal remains of any kind, much more successful. The only relic of this nature which was met with was a portion of a wing-case of some coleopterous insect, and this the wind carried off almost as soon as it was found.

Hazel nuts were extremely abundant—some entire, others broken, and some obviously gnawed. A few appeared to have been flattened as if from long-continued pressure. On digging into this mass and exposing new surfaces, a very disagreeable odour was emitted, which affected some of the party with nausea.

Towards the uppermost or landward margin of the area, the clay was of a bluish lead-colour, and traversed by a considerable number of rectilineal furrows, which, at first, I was inclined to regard as hollows out of which trunks of trees had been washed. This hypothesis, however, appeared to be negatived by the facts that there were no roots, or, indeed, vegetable débris of any kind, to be seen in this part of the clay, and that the longest axis of every furrow was at right angles to the water-line. Hence, to suppose that they had formerly been occupied by trunks of trees, it would be necessary to suppose also that all the latter had fallen in one and the same direction; but this, as has been stated, is by no means borne out by the trunks remaining on the lower belt of the area, where they appear to have fallen towards every point of the compass. In all probability the furrows were scooped out by the waves, perhaps during previous exposures.

If a conjecture may be hazarded on the point, I would suggest that the blue clay is perhaps the substratum on which the brown clay lies, and that the latter, with its vegetable débris, has been stripped off the landward belt of the old forest ground.

It has been stated that the forest area reached the spring-tide low-water line; hence, as the greatest tidal range on this coast amounts to eighteen feet, we are warranted in inferring that the submergence amounted to eighteen feet as a minimum, even if we suppose that some of the trees grew in a soil the surface of which was not above the level of high water. There is satisfactory evidence that in Torbay it was not less than forty feet, and that in Falmouth harbour it amounted to at least sixty-seven feet.[1]

The means at my disposal did not allow me to bring away many samples of the forest for careful examination at leisure, but shortly after my visit I was so fortunate as to meet two gentlemen of Kingsbridge, who, with Mr. Vivian, of Torquay, had also inspected the forest, and on their return kindly sent me a hamper filled with selected portions of the vegetable débris.

To the same gentlemen I am indebted for a rather small horse-chestnut, which, though perhaps somewhat bright, may be said to have the forest aspect. It was found lying loose on the surface of the forest area, and may have been cast up by the waves.

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[1] See Trans. of the Devon. Association, vol. i. pp. 131 and 134. 1868.

Mr. A. Hunt informed me, on March 23rd, 1869, that the forest had entirely disappeared. For about a week immediately preceding there had been strong north-easterly winds, sometimes becoming very heavy gales. The forest therefore could not have remained uncovered for more than a month, or five weeks at the utmost. This, however, was a long exposure when compared with those of earlier periods, according to the accounts which have reached us.

II.—ARCHIVES OF THE NATURAL HISTORY EXPLORATION OF THE COUNTRY OF BOHEMIA. Published for the Committee of Exploration under the direction of Professor Dr. CARL KOŘISTKA, and Professor I. KREJČI.

Vol. I. Contains,[1] under *Orographical Section-Measurements*, one-tenth part of the Map of Bohemia, upon which 4,000 points have been measured and verified.

The *Geological Section* contains :—

(1). A detailed stratigraphical description of the entire Chalk-formation of Bohemia by Professor Krejči.

(2). A Palæontological Monograph of the lowest strata of the Chalk-formation in Bohemia (Upper Greensand) by Dr. A. Fritsch, containing a detailed description of 92 localities.

A plate illustrating new freshwater shells of the "Perncen" strata (lower part of Upper Greensand).

(3). An examination into the microscopic structure of *Eozoon Bohemicum*, with 2 plates by Dr. A. Fritsch.

(4). On Fossil Crinoids, etc., from the Urkalk of Pankratz, by Dr. A. Fritsch.

(5). Additions to our knowledge of the Tertiary Freshwater Gasteropoda of Tucharitz Bohemia, by Alfred Slavik, assistant to Dr. Fritsch in the Museum of Prague.

(6). Note on a *Locusta* from the Braunkolen formation of Bohemia.

III.—THE MINERAL WEALTH OF INDIA.

THE *Englishman* (Calcutta), of the 5th February, 1870, contains some lengthy notes on the Mineral Wealth of India. Their chief object is to show that this wealth has never yet been fully developed, and that no reason exists why wealth, similar to that in which the ancients luxuriated, should not again be realised by those who may be induced to search for it.

The historical evidence is first set forth, and numerous references are made to ancient writers to prove the riches of the land.

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[1] We are indebted to our friend Dr. Anton Fritsch, the able and energetic Keeper of the Palæontological and Zoological collections in the Royal Bohemian Museum, Prague, for the above interesting Report of the contents of the first volume of this truly national work.—*Edit.*

India has been justly reputed for immense mineral wealth, especially in diamonds and other gems, in which she, no doubt, at one time, bore the palm before the rest of the world, but no large amount of the precious metals has been enumerated among her products.

In the Mint, at Delhi, there are ancient traditions of the art of refining both gold and silver.

The so-called "silver mines" at Manikaru have never been worked to any extent, the produce is arsenical pyrites and galena.

Of about twenty mines about to be opened in Kulu, one is an antimony mine, in which a vein, about two feet thick of the solid ore, nearly pure, is reported to exist. Others are of argentiferous galena, yielding a large per centage of copper—90 ounces of silver to the ton, besides lead and gold—while those of copper have not been sufficiently opened up to obtain fair samples for assay. It is expected, however, with additional capital and a larger tutored staff, another year's exploration will add considerably to the known mineral wealth of Kulu and the Southern Himalayan range.

The geological formation of Kulu in the Himalayahs, and especially of Vazeeri Russi, is very favourable to the discovery of the precious metals, being composed of Silurian rocks, sandstone, shales, clay-slate, micaceous and quartzose schists, with numerous quartz lodes, most of which are highly metalliferous.

Burrampore is said to have produced from 2,500 to 3,000 lbs. Troy of gold annually.

That a considerable quantity of lead has been produced in India there can be no doubt, from the quantities the natives used for war purposes as well as sport, and from the many little diggings wherever any indication appeared. The import of gold and silver into India since 1800 has exceeded the export by 256 millions sterling, and the total amount of gold and silver coined exceeds 231 millions sterling, all of which has been absorbed by India.

If India is poor, however, in her produce of precious metals, she makes ample amends for it in her boundless wealth in gems. In the Deccan, in the river Pennair, in the lower Kistna, Ellore, and Punnah, in the river Sonar, in Bundelkund, at Sumbulpore on the Mahanuddy, and numbers of other places in India which produced large quantities of diamonds two hundred years ago, have since become so unproductive, or so neglected, that not only the places themselves but the very names are almost unknown to the present inhabitants.

Garcia al Horto, physician to the Viceroy of Goa, states that diamonds are found in only three or four places. In the province of Besnagar there are two or three rocks that produce them. There is another rock in the Deccan, not far from the territory Imadixa (Imad Shah), etc. These are the stones known by the name of "the diamonds of the old rock," and are brought for sale for Lispor, a town of the Deccan, where there is a noted fair held. The Guzerat merchants buy them and bring them here.

The richest mines, however, were at Golconda, on the gulf of the

Ganges, about 108 miles from Musilipatam. These used to be farmed out for 300,000 pagodas per annum (£150,000). In 1676 no less than 60,000 persons were employed in them. The plan of working was very rude, some of the labourers were employed in digging, others in baling out water by hand, having no mechanical contrivances for that purpose. They sunk shafts ten or twelve fathoms deep, carried out the earth, which was red mixed with white and yellow chalk, and, when dried in the sun, broke and sifted it.

India now sends no diamonds to market. She gets her gold from England, her silver from China, and her copper from Russia. Some gold comes from Yarkand in dust, but in small quantities; also emeralds, rubies, and other gems, precious jade, sulphur, copper, lead, borax, and rock-salt. The mountainous tracts to be crossed, however, prevent, to a great extent, the importation of merchandise from this inhospitable country.

REVIEWS.

I.—MEMOIRS OF THE GEOLOGICAL SURVEY OF ENGLAND AND WALES.

I. The Geology of the Carboniferous Limestone, Yoredale Rocks, and Millstone Grit of North Derbyshire, and the adjoining parts of Yorkshire. By A. H. Green, M.A., F.G.S.; C. Le Neve Foster, B.A., D.Sc., F.G.S.; and J. R. Dakyns, M.A. Appendix and list of Fossils. By R. Etheridge, F.R.S.E., &c. 1869. 8vo. pp. 168. (London: Trübner & Co.)

II. The Triassic and Permian Rocks of the Midland Counties of England. By Edward Hull, M.A., F.R.S., F.G.S. 1869. 8vo. pp. 128. (London: Trübner & Co.)

I. This Memoir is the result of explorations in the field, from 1864–7, by the authors whose names are affixed to the paper; each of whom (with the exception of Dr. Le Neve Foster) describes portions of the country surveyed by himself. The general arrangement of the Memoir has been intrusted to Mr. Green.

The Memoir is prefaced by a useful bibliography of the books and papers relating to the country described from 1700 to 1867, and contains a general description of the physical features, geological structure, and drainage of the district, which is followed by a notice of the formations examined, viz.: Mountain Limestone, Yoredale Rocks, Millstone Grit, and Coal-measures. Next follows a detailed description of these formations, as observed in the different localities examined, and occupies more than 100 pages of the Memoir. The Post-Pliocene, and more recent deposits, follow, including the Boulder beds, the River deposits, and the Clay and Gravels of the Cleaver Hills.

A chapter, embodying a summary of the more important observations, as well as a few points not previously noticed, completes the monograph, to which is appended a valuable list of the fossils of the

Carboniferous Limestone of Derbyshire (never previously attempted), by Mr. R. Etheridge, the Palæontologist to the Survey, zoologically arranged. From this we learn that there are of Cœlenterata, 54 sp.; Echinodermata, 27 sp.; Crustacea, 15 sp.; Brachiopoda, 96 sp.; Lamellibranchiata, 50 sp.; Gasteropoda, 55 sp.; Cephalopoda, 31 sp.; besides some 12 species of fishes. These remains embrace about 12 localities.

Besides three copper-plate engravings, the Memoir is illustrated by 40 woodcuts of the more important sections noticed in the text.

II. This Memoir commences, like the foregoing, with an account of the researches of previous authors who have written upon these formations, and describes the advances made by the officers of the Geological Survey, since they commenced their investigation, now fifteen years ago.

Mr. Hull offers a classification, which is adopted by the Survey, dividing the Bunter Sandstone, or base of the Triassic series, into three parts, namely—

3. Upper Mottled Sandstone.
2. Pebble Beds.
1. Lower Mottled Sandstone.

Overlying these, the Muschelkalk being wanting, occur the lower Keuper Sandstone, the new Red Marl, and Rhætic Beds. The greater portion of the Memoir (from pp. 29–105) is devoted to a detailed description of this group, including its physical geology.

The Permian rocks beneath occupy 20 pages more. There is a remarkable lithological difference between the Permians of this district and those of the north-eastern portion of England. The general absence of Limestones from this area, and their comparative abundance in the typical north-eastern area about Durham, indicating a marked difference in the sources whence the materials of these sedimentary strata were derived. The author recognises in the area described two distinct types, the Salopian and the Lancastrian, showing distinct lithological characters.

As bearing upon the economics of the district, the author traces out the original extent of the Coal strata beneath the formations above noticed in central England, and attempts to determine the lines and districts of disturbance and denudation to which the Coal-measures have been subjected at the close of the Carboniferous period, as well as the upheaval and denudation after the Permian period; and, lastly, the mode of distribution of the Permian and Triassic rocks.

The Sandstones of the lower Keuper series are the most economic of all the Triassic rocks for building purposes, and a list of the best quarries is given.

The Bunter Sandstone, as a source of water supply is also dealt with, and Mr. Hull shows it to be one of the most important water-bearing formations in England.

A list of fossils is appended to the Memoir, which is illustrated by numerous woodcuts.

II.—On the Vindhyan Series, as Exhibited in the North-Western and Central Provinces of India.

By Fred. R. Mallet, F.G.S.

[Memoirs of the Geological Survey of India. Vol. vii., Part i., 1869.]

THE district described in this Memoir comprises a large area, including the greater part of Bundelkund, in size not greatly inferior to England.

Besides his own work, the author combines the work and results of his colleagues, Messrs. H. B. and J. G. Medlicott, C. A. Hacket, W. L. Wilson, and W. T. Blanford. The formations noticed in the area, and coloured on an excellent lithographic map—(scale 32 miles to 1 inch), are as follows:—

	Alluvium.	
	Malva Trap.	
	Intertrappean and Bagh Beds.	
Upper Vindhyan.	Upper Bundair	650 to 2,000ft. in thickness.
	Lower Bundair	500 to 1,500ft. "
	Upper Rewah	300 to 1,000ft. "
	Lower Rewah	450ft. "
	Kymore	1,300ft. "
	Lower Vindhyan	2,000ft. "
	Quartzite Series.	
	Gwalior Series.	
	Bijawur and Slate Series.	
	Gneiss.	

The author first gives a summary of what has been done by previous observers in the same field.

Physical Features.—He then describes the Physical Geography of the district. The area occupied by the Vindhyan rocks, especially in their eastern extension, is one well marked from the surrounding country, both by the greater general elevation of its plateau, and the clearly cut escarpments by which it is almost everywhere bounded. The district is naturally divisible into three so-called table-lands, varying in elevation from 500 to 1,500 feet,[1] each of which has for its floor one of the three grand sandstones of the Upper Vindhyan series, by the names of which, therefore—Kymore, Rewah, and Bundair—the table-lands themselves may be conveniently distinguished.

The Lower Vindhyan formation which skirts these table-lands having been subjected to many disturbances, and subsequent denudation, presents diversified features. While among the schistose rocks which have suffered greater disturbance, and in which there is greater contrast of material, the features are more varied.

The Trappean area presents much diversity in aspect. Plains, more or less level as a whole, in some parts are covered with broad spreads of "cotton soil," where wheat is grown in immense quantities. In some places the ground is broken up and irregular, in others it is shaped into innumerable hills, with only the scantiest vegetation; sometimes it is covered with jungle, at others stony and barren. The form of the trap hills distinguishes them from inlying hills of sandstone, and the vegetation of each is also sufficiently distinct; a very characteristic difference is the abundant supply of teak saplings on the Trappean hills, which are quite uncommon on the sandstone.

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[1] The highest point in the area is Kalumur, a Trappean hill rising from the Bundar table-land 2,544 feet above the sea-level.

Petrology.—Both the Upper and Lower Vindhyan series consist of alternations of Limestones, Shales, Sandstones, and Conglomerates, (distinguished in many cases by local names), but the strata of the Lower series are as a whole calcareous and argillaceous, while those of the Upper are arenaceous and argillaceous; and while, in great part of the Upper series, the beds are thick-bedded and massive, flagginess is a prominent characteristic in the Lower. Lateral alterations are often observed, by which limestones in one locality change to shale in another. Wherever the junction of the two series is seen in section, they are found to be conformable, but there is reason to suppose a slight unconformity really exists. That the Lower was more or less denuded during the formation of the Upper is amply proved by the abundant fragments of its strata frequently observed in the bottom beds of the upper series. The Vindhyan beds have therefore been separated into two divisions.

The thicknesses of the beds vary much in different places, partly from original conditions of deposition, and partly from the effects of subsequent denudation. In the neighbourhood of Rewah, the full thickness of the Upper Vindhyans is about 2,500ft., while in the Dhar forest it has been estimated at 10,000ft. At Rotasgurh the Lower Vindhyans are about 2,000ft. thick.

As yet no reliable fossils have been found in either the Upper or Lower Vindhyans.

Age.—Their age, relatively to the stratified formations newer, cannot be determined by the test of superposition, as no more recent deposits anywhere overlie them, except such as are known to be vastly younger. They rest, with marked unconformability, on the older rocks.

The Vindhyans are in the Indian scale mediate between the Bijawurs and Gwaliors on one hand (the relative age of which to each other is yet uncertain), and the Talchirs on the other. This latter is the first formation beneath the lowest coal as far as is yet known.

With regard to their age, according to the European standard, little can be said. In a previous volume of the Memoirs, Dr. Oldham pointed out the probability of the Damuda system, representing in part the Permian and Upper Carboniferous periods, which would indicate for the Vindhyans, therefore, some age older than the Upper Carboniferous. Mr. Mallet remarks that it would be curious if they were to turn out of Old Red Sandstone age, as to this period they were referred, in 1825, by Dr. Voysey, for no other reason than their lithological similarity.

Denudation.—The Vindhyan area, especially in the eastern districts, presents a fine field for the study of denudation. The entire features appear to be the result of subäerial agencies, in support of which Mr. Mallet adduces several striking instances.

Mineral Wealth.—No metallic wealth has yet been discovered in the Vindhyan series, nor, as the author remarks, was it to be expected in such an accumulation of sandstones. Their mineral resources, with one remarkable exception—the diamond mines of Punna[1]—are chiefly confined to building stones and limestones. Superficial deposits of iron-ore occur scattered over the Kymore table-land, which are worked to some extent, and brown hæmatite occurs on the Punna range of hills. Iron pyrites occur in the black Bijigurh shales (of the Kymore Group). The black colour of these shales led to a belief that coal existed, but it is now well known that none of it exists in the Vindhyan formation.—H. B. W.

III.—"ON THE STRATA OF THE EARTH'S CRUST, AND THE FOSSILS CONTAINED IN IT." By DR. ANTON FRITSCH, of Prague.

[O vrstvách kůry zemské a skamenělých tuorech v nich obsažených. Sepsal. Dr. Antonín Frič. v. Praze, 1869. 12mo. pp. 232, profusely illustrated.]

Under the above title Dr. Fritsch publishes, at Prague, in the *Czechian-Slavonic* language, a Popular Geology, written for the Bohemian people, and illustrated with 473 well-executed woodcuts of sections and fossils, etc., mostly found in Bohemia.

First, there is an introductory chapter on the nature of geological research, and the places to be visited around Prague where fossiliferous strata are to be met with. Then succeeds an outline of the zoological orders represented in a fossil state, from the microscopic *Diatomaceæ* to the remains of the Mammoth and Rhinoceros. Thirdly, we have a brief account of the chief physical agencies at work upon the crust of our globe, and the subterranean forces manifesting themselves in earthquakes, elevations, and sinkings of the land, and the outbursts of volcanos. The formation of sedimentary deposits beneath the sea, and their subsequent elevation at different angles, so as to form our hills and mountains, are each illustrated, as is also their subsequent waste and erosion into ravines, valleys, and plains. The arrangement of the rest of the work is stratigraphical, each formation being illustrated by its characteristic fossils from the Primordial zone to the Quaternary deposits and the Swiss pile-works.

The groups of fossils illustrating the book have the great recommendation of being *correctly drawn*—a feature too often neglected in cheap popular works on geology and palæontology, the artists appearing to think that "anything will do for a fossil."

What we particularly wish to call attention to, is the interesting intelligence that a society in Bohemia, formed for the purpose of publishing cheap books, have printed 20,000 copies of Dr. Fritsch's little geological handbook, to be sold at the price of 4½*d.* each! and, what is still more to the purpose, they have *already sold* 14,000 copies! We congratulate both the author and the Society on such good success attending their efforts for the promotion of a love of Natural Science among their fellow-men. When will 20,000 copies of an English geological book (even at 4½*d.*) be printed? and when will 14,000 be sold?

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[1] Diamonds occur in the Punna Shales (Rewah group). *Vide* Mr. Medlicott's Report, Mem. Geol. Survey of India, vol. ii., p. 65.

IV.—Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord, and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Edited by Professor T. Rupert Jones, F.G.S. Part x. February, 1870. 4to. Six Plates. London: H. Baillière.

IF the original announcement be adhered to, namely, to complete this great work in twenty parts, the remaining author, and the editor have now arrived at the half of their travail. The last number appeared in September, 1869, and we noticed it in our October number, Vol. VI. p. 463. Part I. appeared in December, 1865, so that we may look forward to the completion of this exhaustive memoir on Pre-historic antiquities in 1874, or thereabout. If the future ten parts prove as rich as those already issued, it will, as a publication on this branch of archæology, be unrivalled; but we think we must have seen the largest half of these fine illustrations already.

The present part contains a plate of engraved stones, on which, as upon the bones, already noticed in earlier parts of the work, there are figures apparently of the Horse and Reindeer. Such stones, with engraved figures of animals, were very rare in 1863, when the authors obtained those now figured. But since then some have been found at other stations of the same Reindeer Period, especially at Bruniquel. The pieces of sandstone figured in Plate xxx. have evidently served for grinding and polishing; the deep grooves upon the face of several of them would indicate that they had been used in the preparation of bone implements. Two excellent plates of Flint flakes, more or less dressed into shape, are followed by two of Bone implements and ornaments.

Some of the bone needles figured are three inches in length, the smallest is seven-eighth of an inch long; they appear to have been sharpened on the pieces of sandstone, already mentioned, whenever they were blunted, which we think must have been often, when used for sewing skins.

In M. Lartet's admirable article "On the Employment of Sewing-needles in Ancient Times," in the present number of the "Reliquiæ," he says (p. 138)—"All tends to make us admit that, like the Laplanders and Esquimaux of the present day, the ancient Cave-folk of Perigord must have used the tendons of the Reindeer in sewing their clothes that were made of skins; and as the needles of these primitive times vary considerably in form and dimensions, it may well be assumed that they also knew at that time how to split the tendons, and to make them into threads of different degrees of fineness, so that they could be used for different kinds of needlework."

Some of the ornamental work upon the carved bone or horn articles, figured in the last plate, may evidently be classed with the modern American occupation of "Whittling," and must have been a great amusement on a rainy day. The wavy and zig-zag patterns are similar to those seen upon early hand-made, and often sun-dried pottery.

V.—REPORT OF THE 29TH MEETING OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, held at Exeter, August, 1869. London, 1870. 8vo. pp. 704. John Murray.

MR. GEORGE GRIFFITHS, the Assistant General Secretary, has displayed great diligence in bringing out the annual volume of reports and proceedings so soon after the meeting. Among the numerous papers of geological interest, we select one which appears especially deserving the attention of our readers.

REPORT ON ICE AS AN AGENT OF GEOLOGIC CHANGE. By a Committee, consisting of Professor Otto Torell, Professor Ramsay, LL.D., F.R.S., and H. Bauerman, F.G.S.

We are of opinion that the work already done in the investigation of the phenomena connected with ice is not sufficient to enable us to prepare a Report showing the precise effect of "ice as an agent of geologic change;" but enough has been done to show in part the manner in which the subject may be followed, for the purpose of obtaining information as to the quantitative action of glaciers, both as regards their erosive and transporting powers.

1st. We would select a well-known glacier-region, such as the Alps, and there for preliminary investigation fix on a large glacier, simple in structure, and easily accessible, such, for example, as the lower glacier of the Aar. If not already done, the glacier and the surrounding mountains ought to be well surveyed and mapped, and its moraines clearly expressed.

2nd. The amount of rocky and earthy matter forming each medial and lateral moraine would require to be determined as accurately as possible, probably in the manner illustrated by the accompanying rough diagram of an imaginary glacier.

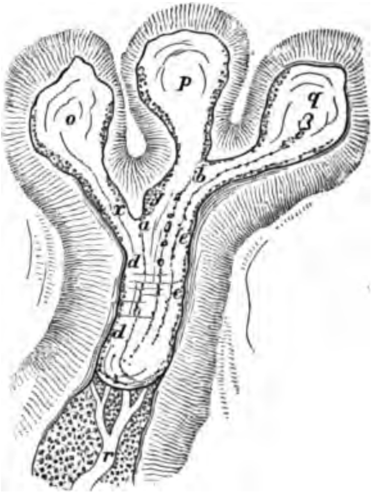

Diagram of a Glacier.

Take of the medial moraine marked *a* a space, say, from 100 to 500 yards in length, and estimate the solid contents of that portion of the moraine. This should be done as near as possible to the place where the medial moraine is formed by the union of the two lateral moraines *x* and *y*; for lower down part of the material may disappear by falling into crevasses. The same must be done for the moraines *b* and *c*, or for each of the medial moraines; and also, in several places, for the lateral moraines *d* and *e*. Then ascertain the rates of the onward movement of the glacier, according to circumstances, in various portions of its length, and at various seasons of the year; and by these means will be ascertained to a great extent (but not precisely) the quantity of matter carried annually on the surface of the glacier to its termination, and this matter will represent a very large part of the waste of the sides of the mountains that bound the snow and glacier basins *o*, *p*, *q*, and the sides of the mountains that bound the glacier lower down towards its terminal moraine.

3rd. The chief part of the *remainder* of the rocky and earthy matter that is carried from the mountains to the level of the glacier, will pass under it at its sides, and mingle with the material that finds its way to the bottom of the glacier by means of crevasses and moulins, and also with that which is the product of the erosive action of the glacier exerted on its bed, and on the stone blocks imprisoned at the bottom of the ice. A small part of the above-named *remainder* may also be caught in the ice, and imprisoned in rejoined crevasses.

4th. We see no way of precisely estimating the amount of erosion produced by the weight and movement of the glacier—that is to say, the rate at which any given glacier may deepen and widen its valley by pure wearing action, owing to the circumstances that the sediments discharged along with the water that flows from the end of a glacier do not represent the amount produced by mere erosive force, for the reason stated under head 3. But it is essential to the main question that correct estimate should be made of the amount of solid matter brought from under the glacier by the help of running water, and also of the amount carried away by the continual wasting of streams of the terminal moraine.

As regards the matter in suspension in the river, and also that forced along its bottom, it should be estimated, if possible, at a point *r*, just below where various streams unite that flow from the ends of most great glaciers. Where there is only one stream (as in the Aletsch glacier), the closer the better. The operation would be very laborious; for, unless frost and snow prevented it, it would require to be done for every day in a year or years, and several times each day, at least in summer and autumn, and probably in spring and winter also. For example, in summer the quantity of water varies largely, according to the heat of various periods of the day; and it would probably be necessary to make an observation every day before sunrise, another some time before noon, another between four and six o'clock in the afternoon, and another after nightfall; in fact sufficiently often to obtain an average for each day in the year.

With regard to the transport of heavier matter from the terminal moraine (which forms a portion of this part of the subject) by means of the estimates indicated under head 2, assuming that all terminal moraines are formed chiefly from matter transported on the surface of the glacier.

5th. If the foregoing methods are correct, they might afterwards be applied to all the glaciers of the Alps, and the rate of waste and transport by glacier action might be approximately determined; and in like manner they might also be used for well-known and comparatively accessible mountain-ranges like the Scandinavian chain, the Himalayas, the mountains of New Zealand, and in time to the Rocky Mountains, the Andes, and others.

6th. But the above only forms part of the subject, and to attempt to estimate the existing importance of "ice as an agent of geological change," the *glacier* and *glacial* phenomena generally, as regards erosion and terrestrial and marine transport of material, must be taken into account in such regions as Spitzbergen, Greenland, and Victoria Land in the southern hemisphere. Something on a small scale may be done in Spitzbergen and the southern part of Greenland; but at present we see no likelihood of definite observations being made on the western side of Greenland further north, and in the extreme north of that continent, or on its eastern shores, either in respect to the erosion produced by its great glaciers, the effect of floe and shore ice, or the transporting work done by the icebergs that float southwards from its shores.

Something is known of the general result, but it seems very improbable, with regard to the number and size of icebergs, and the quantity of matter they bear southwards, that anything definite is likely to be ascertained at present. The same remarks bear yet more strongly on the glacial phenomena of Victoria Land.

7th. But when so much remains to be done on the Alps, and on other accessible mountain areas, such difficult points can afford to wait for the present, and we are of opinion that, perhaps, it is possible, after the subject has been investigated with regard to the existing glaciers of the Alps, to apply approximately the same method to the older extension of the Alpine glaciers during the last glacial period, and to invent a process by which we may be able, in some degree, to estimate the amount of erosive waste, and of transport of moraine matter on the surface of the great glaciers of that epoch. Accurate surveys of old moraines of that epoch would be essential to this end, such, for example, as that of the great moraine of Ivrea. The extent of the glacier has been shown by Gastaldi, and the area occupied by, and cubic contents of, the moraine must be estimated; and if it be possible to feel our way towards data, attempts must be made to estimate the amount of waste of the moraine going on at the time it was deposited by the streams flowing from the end of the glacier. Numerous other considerations arise from this extended view of the question, one of which is, that, perhaps, it may be applied to other glaciated regions where glaciers no longer exist, such as the Vosges, the Black Forest, Wales, the North of England, Scotland, &c., thus:—Given an area such as the Alps and the Lowlands of Switzerland covered with glacier-ice; if an approximate estimate can be formed of the amount of waste suffered by that land, due to glacier-action, so under like circumstances is it possible, more or less accurately, to estimate the amount of erosions and other waste suffered by an equal area in such a territory as the North of Greenland at the present day.

In conclusion, any qualified person, with proper assistance and time at his disposal, could undertake the preliminary work on a single glacier; but to do what is necessary to complete it for such an area as the Alps would, probably, involve national scientific co-operation.

VI.—Dr. C. W. Gümbel's Researches in Fossil Foraminifera and Entomostraca.

§ I. AMONG the additions lately made to our knowledge of the Microzoa of past times, we have especially to notice two works by Professor Dr. C. W. Gümbel, Bergrath, etc., of Munich. In one of these memoirs we have a monograph of the Foraminifera, associated with Nummulites in the Kressenberg Nummulitic Strata, or Lower Eocene beds, of the North Alps.[1]

The Geology of the Bavarian Alps and their Nummulitic Strata was described by Dr. Gümbel in his Geognostische Beschreibung der bayerischen Alpen in 1861; but at that time few Foraminifera besides the Nummulites had been detected in these strata. He now explains how further research has discovered innumerable Microzoa in the marls and limestones, under different conditions,—loose, compact, and as siliceous casts.

Dr. Gümbel's carefully drawn plates illustrate the Foraminiferal fauna of the Kressenberg Strata, excepting the Nummulites. This fauna approaches in general aspect that of our London Clay, and of the Septarium-clay of Hermsdorf (Prussia), but differs from either in the abundance of *Orbitoides*, *Operculinæ*, and *Nummulinæ*. *Heterostegina*, *Calcarina*, and *Alveolina* are also associated with these, and are very rare, or absent, in the two Eocene formations mentioned above, which, on their part, are not deficient in *Miliolæ*, a group not represented in Dr. Gümbel's Bavarian plates. The Bracklesham sandy beds, with their abundant *Alveolinæ* and *Nummulinæ* are, of course, the well-known equivalents of these true Nummulitic limestones and marls; but they have, in other respects, a poor Foraminiferal fauna, though they add abundance of *Miliolæ* and *Discorbina turbo* to the list. The Grignon beds (Lower Tertiary) are both Miliolitic and Nummulitic, and have many of the Bavarian species, together with a great variety of others, not met with in the Northern Alps by Dr. Gümbel and his associates. A monograph of the Foraminifera of the Parisian Tertiaries is much wanted.

The Middle Tertiaries of Vienna, as represented by D'Orbigny,

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[1] Beiträge zur Foraminiferenfauna nordalpinen, älteren Eocängebilde oder der Kressenberger Nummulitenschichten. 4to. Munich, 1868. Extracted from the Transactions of the Royal Bavarian Academy of Sciences, Cl. 2; vol. x., Part II., pp. 581–730. With four plates.

Reuss, and Czjzeck, have many of the Bavarian Eocene Foraminifera, but are deficient in *Orbitoides* and *Nummulina*; *Amphistegina* predominating instead, with *Miliolinæ*, *Polymorphinæ*, etc. The Malaga Clay also, and most of the Subappenine Beds, yield in abundance several of the forms figured by Dr. Gümbel, especially the *Nodosarinæ*, and these of larger growth; and the existing representatives of nearly all the species are found plentifully in the Australasian and other warm seas. In fact, as long ago observed, it is mainly to Australia and the neighbouring regions that we have to look for the successors of the beautiful Foraminifera of the Grignon and other Tertiary sea-beds of Europe.

In the Scindian equivalents of the European Nummulitic beds, *Orbitoides*, *Alveolinæ*, etc., abound as in Bavaria; and *Orbitoides* are abundant in the West-Indian Middle Tertiaries, though rare or wanting in their European equivalents.

Of the several groups of Foraminifera, arranged according to Carpenter and other English Rhizopodists, the Bavarian list before us supplies the following:—

MILIOLIDA: *Cornuspira*, 1 (probably a *Trochammina*); *Alveolina*, 1. LITUOLIDA: *Trochammina*, 1 (?); *Lituola* (*Haplophragmium*), 1. LAGENIDA: *Lagena*, 4; *Glandulina*, 1; *Lingulina*, 2; *Nodosaria*, 24; *Dentalina*, 14; *Vaginulina*, 3; *Marginulina*, 7; *Cristellaria* (and *Robulina*), 16 (*Nodosarinæ*, 71); *Orthocerina* (*Rhabdogonium*), 1; *Uvigerina*, 1; *Polymorphina* (and *Globulina*), 5. GLOBIGERINIDA: *Globigerina*, 4; *Clavulina*, 1; *Gaudryina*, 2; *Pleeanium*, 2; *Venilina*,[1] 2; *Textilaria*, 1 (*Textilarinæ*, 8); *Virgulina* (*Pleurostomella*), 1; *Discorbina*, 2; *Planorbulina* (*Rotalia*, *Rosalina*, *Truncatulina*), 15 (?); *Pulvinulina* (*Rotalia* and *Rosalina*), 3; *Calcarina*, 1. NUMMULINIDA: *Operculina*, 3; *Nummulina*, 16 (not figured); *Heterostegina*, 1; *Orbitoides*, 20.

It seems probable that further research will supply more of the *Miliolida*, if not of some other groups also, to bring up this list of genera to the usual complement of such a Rhizopodal Fauna as the above abstract indicates to have existed in the Nummulitic Sea.

As of interest to Rhizopodists, it may be well here to point out the probable relationship of the *Rotalinæ* treated of by Dr. Gümbel, who groups them mostly in an old-fashioned manner, as *Rotalia*, *Rosalina*, and *Truncatulina*. 1. DISCORBINA: *D. polysphærica*, pl. 2, f. 95; *D. megasphærica*, f. 96 (= *D. globigerinoides*, Parker and Jones). 2. PLANORBULINA: *Rotalia megomphalus*, f. 94 *bis*; *Rot. pteromphalia*, f. 88; *Truncatulina kallomphalia*, f. 102 (these three are near *Pl. Haidingeri*); *R. truncana*, f. 43 (near *Pl. Ungeriana*); *Rot. capitata*, f. 92; *Rosalina rudis*, f. 99; *Truncat. grasserugosa*, p. 104 (these three are very near to *Pl. ammonoides*, if not identically the same); (subgenus TRUNCATULINA) *Rot. ammophila*, f. 90; *Rot. macrocephala*, f. 91; *Truncat. sublobatula*, f. 103; *Rot. cochleata*,

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[1] Dr. Gümbel has instituted the new genus *Venilina* for those Textilarian forms that commence with an alternate series of compressed oblique segments (*Grammostomum*), and end in a single series, such as the bi-uniserial sub-varieties mentioned in Ann. N. H., ser. 3, vol. xi., p. 93.

f. 94; *Ros. calymene*, f. 100; *Truncat. cristata*, f. 105 (the first three are near the common *Tr. lobatula*; the last three are near *Tr. coronata*, and indeed the last one is almost the same). *Rot. eocaena*, f. 87, and *Ros. subumbonata*, f. 98, are also possibly *Planorbulinæ*. PULVINULINA: *Rot. bimamata*, f. 85; *Rot. campanella*, f. 86; *Ros. asterites*, f. 101 (= *Pulv. Menardii*, deep-sea form). It is difficult to place *Rotalia polygomata*, f. 89. No true *Rotalia* is figured among the above.[1]

The monograph on *Orbitoides*, forming part of Dr. Gümbel's Memoir (pages 670–725), and illustrated by plates 3 and 4, and part of pl. 2, is very welcome.

§ II. In the "Jahrbuch der kais. königl. geologischen Reichsanstalt, 1869, vol. xix., pages 175–186," Dr. C. W. Gümbel has given a notice of the Foraminifera, Ostracoda, and other microscopic organic remains found in the Saint-Cassian and Raibl formations. From these beds of the Upper Trias, Prof. A. E. Reuss had previously noticed[2] some Foraminifera (*Glandulina obconica*, *Cristellaria*, *Marginulina*, *Globigerina*, *Polymorphina*, *Textilaria*, *Cornuspira filiformis*, and *Biloculina*; also two Entromostraca, *Cythere Cassiana* and *Cytherella limbata*. Dr. Gümbel now describes and figures, from the *Cardita-crenata* beds, three *Dentalinæ* (of the universal *D. communis* type), *D. korynephora*, *D. Cassiana*, and *D. transmontana*; *Glandulina pupiformis*; *Cristellaria Cassiana* (of *Cr. rotulata* type); *Polymorphina? longirostrata*; *Cornuspira* [or *Trochammina*] *pachygyra*; and *Rotalia Cassiana*, which is a *Pulvinulina*, near to *Pulv. Karsteni*, Reuss, sp. Minute calcareous plates of Echinoderms, &c., accompany these; also *Bairdia Cassiana*, Reuss, sp., and *B. Marrubiana*.

From Raibl (the *Myophoria-Raibliana* beds) Dr. Gümbel has *Nodosaria Raibliana* (of the common *N. raphanus* type), *Lingulina intumescens*, *Planularia pauperata*, P. and J., *Guttulina? Raibliana* (a common *Polymorphina*), *Triloculina Raibliana* (like *Tr. oblonga*), and some of the St.-Cassian forms. Also the following Ostracoda: 1. *Cytherella Raibliana*; 2. *C. subcylindrica*, Sandberger, sp.; 3. *Bairdia Carinthiaca*; 4. *B. perlata*; 5. *Cythere Raibliana*; and 6. *C. tuberculifera*. *C. fraterna*, Reuss, from Raibl, had been previously published. The generic relationships of nearly all these are very doubtful. No. 2 looks somewhat like a *Limnicythere*; No. 3 does not look like a *Bairdia*; nor does No. 4 (probably a *Loxoconcha*). No. 5, a very neat form, has possibly some alliance with *Cytheropteron*. No. 6 is strange; it may be allied to *Cytherella*, and so may No. 2, as suggested by Gümbel.[3] *C. fraterna* seems to be a *Cytherella*.

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[1] The *Rotalinæ* have been especially studied by Mr. W. K. Parker, and his classification and definitions may be found in Carpenter's "Introd. Study of Foram.," and in the "Phil. Trans.," vol. clv. (1865), p. 378, etc. To these works the attention of naturalists, treating of fossil and recent Rotalines, should be particularly directed.

[2] Sitzung. Akad. Wissensch. Wien, vol. lvii. p. 26, &c.

[3] The palæontologist has now a broader and firmer base, than heretofore, for his comparisons of fossil Ostracoda with the existing forms, in the late Memoirs on the living genera and species, by Mr. G. S. Brady; in the Transactions of the Zoological and Linnean Societies; the "Annals of Nat. Hist.;" the "Fonds de la Mer," etc.

These remnants of the Triassic fauna, taken together with other microzoa of Triassic and Rhætic age, published by Sandberger, Reuss, von Seebach, Jones and Parker, von Schauroth, Peters, and Schwager, certainly extend our view of the Marine Zoology of that early Mesozoic period; but still offer no forms of life widely different from the present microzoic inhabitants of the sea.—T. R. J.

VII.—REVIEW OF THE CONTRIBUTIONS TO FOSSIL BOTANY PUBLISHED IN BRITAIN IN 1869.[1]

By WILLIAM CARRUTHERS, F.L.S., F.G.S., of the British Museum.

During the year the following papers have been published:—

BAILY, W. H.—Notice of Plant-remains from Beds interstratified with the Basalt in the County of Antrim. Quart. Journ. Geol. Soc., vol. xxv. pp. 397-362, pl. xiv. and xv.

These beds occur under similar conditions to those in the Island of Mull, and contain a series of allied fossils, chiefly dicotyledonous leaves and fruits; wood, foliage, and cones of *Coniferæ;* and leaves of endogens. They are considered to be of Miocene age.

BRONGNIART, A.—Notice of a Fossil Lycopodiaceous Fruit. (Translated from the "Comptes Rendus," August, 1868.) Journ. Bot. vol. vii. pp. 3-8; Ann. Nat. Hist. ser. 4, vol. iii. p. 74.

The author had obtained a complete specimen of the cone described from the upper portion by Robert Brown, under the name *Triplosporites.* He shows that the lower portion contains macrospores and the upper microspores, as in the recent genus *Selaginella.*

CARRUTHERS, W.—On some undescribed Coniferous Fruits from the Secondary Rocks of Britain. GEOL. MAG. Vol. VI. pp. 1-7, pl. i. and ii.

Several species are described, and the views of M. Pomel regarding *Brachyphyllum,* etc., are examined, and his family *Lepidocarpieæ* shown to be based on erroneous interpretation.

———— On *Beania,* a New Genus of Cycadean Fruit from the Yorkshire Oolites. GEOL. MAG. Vol. VI. pp. 97-99, pl. iv.

A fruit nearly allied to the cone of *Zamia,* but having the scales scattered over the axis, so as to form a loose spike.

———— On the Plant-remains from the Brazilian Coal-Beds, with Remarks on the Genus *Flemingites.* GEOL. MAG. Vol. VI. pp. 151-156, pl. v. and vi.

Three Palæozoic species are described. From the materials from Brazil, a more complete diagnosis of *Flemingites* is given, and its affinities examined.

———— The Cryptogamic Forests of the Coal Period, being a lecture before the Royal Institution of Great Britain. Proc. Roy. Inst., and GEOL. MAG. Vol. VI. pp. 289-300; woodcuts.

An attempt to show the relation between the Palæozoic and existing vascular Cryptogams.

———— On the Genus *Knorria.* Journ. of Bot. vol. vii. pp. 153-155, pl. xciii.

Showing that this genus is based upon casts of the interior of Lepidodendroid stems.

———— On the Structure of the Stems of the Aborescent *Lycopodiaceæ* of the Coal Measures. No. I. *Lepidodendron selaginoides,* Sternb. Month. Micro. Journ. vol. i. pp. 177-181, pl. xxvii.

———— Ditto. Ditto. No. II. *Ulodendron minus,* Lindl. and Hutt. Month. Micro. Journ. vol. i. pp. 225-227, pl. xxxi.

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[1] We reprint this important paper from *Seemann's Journal of Botany* for March, 1870.

The author proposes to describe the minute structure of these stems, and compare them with recent structures. Two forms are described in these papers.

CARRUTHERS, W.—On the Structure and Affinities of *Sigillaria* and allied Genera. Quart. Journ. Geol Soc. vol. xxv. pp. 248–254, pl. x.

The structure of the known parts of this genus is described, and it is referred to *Lycopodiaceæ*.

COEMANS, EUG.—Note sur la Famille des Equisétacées. Journ. Bot. vol. vii. pp. 337-340.

The author reviews the different parts of *Calamites* which have received separate names, and unites them under four genera,—*Calamites*, *Annularia*, *Sphenophyllum*, and *Phyllotheca*,—in the suborder *Calamitea* of *Equisetaceæ*.

DAWSON, J. W.—On *Calamites*. Ann. Nat. Hist. ser. 4, vol. iv. pp. 272, 273.

The author confirms the views of M. Grand'Eury, but in two points his observations differ from those of M. Grand'Eury. None of his specimens had long rhizomes, the secondary stems budding almost directly from the primary; and he has found leaves in connection with three species.

GRAND'EURY.—Observations on *Calamites* and *Asterophyllites*. (Translated from the "Comptes Rendus," March, 1868.) Ann. Nat. Hist. ser. 4, vol. iv. pp. 124–128.

From observations on upright *Calamites* in the coal-measures of the Loire, he describes this genus as having creeping rhizomes; articulated, fistular, and septate stems; the thin outer portion of which consists of (1), an exterior cortical layer, now converted into coal; (2), a thin layer of vascular tissue, now invariably destroyed; and (3), a sort of inner lining of epidermis, which is carbonified. The flutings are on the outer surface of the thin vascular cylinder. There is no evident trace of the insertion of leaves. The greater number of *Asterophyllites* he considers as belonging to other stems than *Calamites*, and for them he proposes the name *Calamophyllites*, and distinguishes them from *Calamites* as having articulate, very certainly hollow, and septate stems, of herbaceous nature, and not always regularly striate; leaves caducous, situated above the articulation; and caducous branches rising above the articulations in the axils of the leaves.

HANCOCK, A., and T. ATTHEY.—On some curious Fossil Fungi from the Black Shale of the Northumberland Coal-field. Ann. Nat. Hist. ser. 4, vol. iv. pp. 221–228, pl. ix. and x.

The authors describe a number of lenticular bodies from the Cramlington black shale, which, from their resemblance to *Sclerotium stipitatum*, Berk. and Curr., they consider to be *Fungi*. These fossil bodies are supposed by Messrs. Hancock and Atthey to be fully-developed plants, producing spores, and related to the higher *Fungi*. The authors have overlooked the fact that this "doubtful" (Berk.) production, which led them to take this view of these bodies, is only a *mycelium*-tuber, the fructification of which is yet unknown. Five species are described.

HICKS, H.—Notes on a Species of *Eophyton* (?) from the Lower Arenig Rocks of St. David's. GEOL. MAG. Vol. IV. pp. 534, 535, pl. xx.

It is very doubtful whether this fossil belongs to the vegetable kingdom. The large-sized continuous tubes of which it is composed are unlike plant-structure.

LINNARSSON, J. G. O.—On some Fossils found in the *Eophyton* Sandstone at Lugnas in Sweden. (Translated from the Danish Roy. Acad. Ofversigt for March, 1869.) GEOL. MAG. Vol. VI. pp. 393-406, pl. xi.-xiii.

Some additional forms of the impressions from these ancient beds are figured and described, establishing that they represent plants of a high organization, most probably monocotyledonous, as supposed by Torell.

MAHONY, J. A.—On the Organic Remains found in Clay near Crofthead, Renfrewshire. GEOL. MAG. Vol. VI. pp. 390–393.

The author enumerates the following recent plants as found in stratified beds of sand and mud, intercalated with Boulder-clay, viz.:—3 species of *Desmideæ*, 31 of *Diatomaceæ*, 10 of *Musci*, 9 of *Phanerogamia*.

NICHOLSON, H. A.—On the Occurrence of Plants in the Skiddaw Slates. GEOL. MAG. Vol. VI. pp. 494–498, pl. xviii.

The author figures and describes four fossils, which he thinks most probably plants.

WANKLYN, A.—Description of some New Species of Fossil Ferns, from the Bournemouth Leaf-bed. Ann. and Mag. Nat. Hist. ser. 4, vol. iii. pp. 10–12, pl. i.

The Ferns are rare in these beds. Four forms are figured, two probably fragments of *Adiantum* and of a species of *Cyathea*. The others represent two species of *Gleicheniaceæ*, for which the author proposes the genus *Mertensites*, which must, however, be set aside, as it exactly agrees with Debey and Ettingshausen's genus *Didymosorus*, containing three plants from the Cretaceous beds of Aix-la-Chapelle.

WILLIAMSON, W. C.—On the Structure of the Woody Zone of an undescribed form of Calamite. Mem. Lit. and Phil. Soc. Manch. ser. 3, vol. iv. pp. 155–183, pl. i.–v.

The specimen is elaborately described, and the genus *Calamopitus* is established for those forms of Calamite "in which the woody elements consist of reticulated vessels associated with medullary rays, and having verticils of medullary radii near the nodes."

———————— Additional Notes on the Structure of *Calamites*: Abstract Proc, Lit. and Phil. Soc. Manch. vol. viii. pp. 153–155.

The author is satisfied that the stem had an exogenous growth, with cryptogamous fruit.

———————— On a New Form of Calamitian *Strobilus*: Abstract. Proc. Lit. and Phil. Soc. Manch. vol. ix. pp. 7–9.

This fruit is supposed to belong to the author's genus *Calamopitus*, and differs from the *Volkmannia* described in Journ. Bot. vol. v. p. 349, in the sporangia being supported on a sporangiophore rising from the surface of the scales.

———————— On the Structure and Affinities of some Exogenous Stems from the Coal-measures. Month. Micr. Journ. vol. i. pp. 66–72, pl. xx.

A new genus (*Dictyoxylon*) is established for the exogenous stems of the coal-measures, whose tissues are composed of reticulated fibres.

Synopsis of the Genera and Species described in the preceding Papers.

FUNGI ?

Archagaricon bulbosum, globuliferum, radiatum, dendriticum, conglomeratum, Hancock and Atthey, Ann. Nat. Hist. ser. 4, vol. iv. p. 226. *Carboniferous.* Cramlington, Northumberland.

FILICES.

Mertensites Hantoniensis, Wanklyn (*Didymosorus*, Deb. and Ettings.), Ann. Nat. Hist. vol. iii. ser. 4, p. 10; pl. i. figs. 1 *a–g*. *Eocene.* Bournemouth.

M. crenata, Wanklyn (*Didymosorus*, Deb. and Ettings.), l. c. p. 12; pl. i. fig. 3. *Eocene.* Bournemouth.

Noeggerathia obovata, Carr. GEOL. MAG. Vol. VI. p. 154; pl. vi. fig. 1. *Carboniferous.* Rio Grande do Sul, Brazil.

Odontopteris Plantiana, Carr. l. c. p. 154; pl. vi. fig. 2 and 3. *Carboniferous.* Rio Grande do Sul, Brazil.

EQUISETACEÆ.

Calamites. Journ. Bot. vol. vii. p. 337; Ann. Nat. Hist. vol. iv. pp. 124, 272.

Calamopitus, Williamson, Mem. and Proc. Lit. and Phil. Soc. Manch, vol. ix. p. 7.

Calamophyllites, Grand'Eury, Ann. Nat. Hist. vol. iv. p. 124.

LYCOPODIACEÆ.

Knorria. Journ. Bot. vol. vii. p. 153; pl. xciii.

Sigillaria. Quart. Jour. Geol. Soc. vol. xxv. p. 248; pl. x.

Triplosporites Brownii, Brong. Journ. Bot. vol. vii. p. 3. *Carboniferous.* From the Drift, Volpe, Haute-Garonne, France.

Flemingites Pedroanus, Carr. GEOL. MAG. Vol. VI. p. 151; pl. v. *Carboniferous.* Rio Grande do Sul, Brazil.

Lepidostrobus selaginoides, Sternb. Month. Micr. Journ. vol. i. p. 177; pl. xxvii. *Carboniferous.* Halifax.

Ulodendron minus, Lindl. and Hutt. l. c. p. 225; pl. xxxi. *Carboniferous.* Bradford.

MONOCOTYLEDONES ?

Eophyton Linnæanum Torell, GEOL. MAG. Vol. VI. p. 399; pl. xi. figs. 3 and 4. pl. xii. *Lower Cambrian.* Lugnas, Sweden.

E. Torelli. Linnars. l. c. p. 402; pl. xiii. *Lower Cambrian.* Lugnas, Sweden.

E. (*?*) *palmatum,* Nich. GEOL. MAG. Vol. VI. p. 497; pl. xviii. fig. C. *Llandeilo.* Barff, Keswick.

E. (*?*) *explanatum,* Hicks, GEOL. MAG. Vol, VI. p. 535; pl. xx. *Arenig.* Ramsey Island, St. David's.

CYCADEÆ.

Beania gracilis, Carr. GEOL. MAG. Vol. VI. p. 97; pl, iv. *Oolite.* Scarborough.

CONIFERÆ.

Dictyoxylon Oldhamium, Williamson, Month. Micr. Journ. vol. i. pp. 70. *Carboniferous.* Lancashire.

Pinites Leckenbyi, Carr. GEOL. MAG. Vol. VI. p. 2; pl. i. fig. 1-5. *Lower Greensand.* Shanklin, Isle of Wight.

P. gracilis, Carr. l. c. p. 2; pl. i. fig. 9. *Gault.* Folkestone.

P. gracilis, Carr, l. c. p. 2; pl. ii. fig. 10. *Kimmeridge Clay.* Weymouth.

P. Plutonis, Baily, Quart. Journ. Geol. Soc. vol. xxv. p. 360; pl. xv. fig. 1, 2. *Miocene.* Antrim.

Araucarites Brodiei, Carr. GEOL. MAG. Vol. VI. p. 3; pl. ii. figs. 1-6. *Stonesfield Slate.* Stonesfield.

A. Phillipsii, Carr. l. c. p. 6; pl. ii. fig. 7-9. *Oolite.* Yorkshire.

Sequoiites Gardneri, Carr. l. c. p. 7; fig. 7 and 8. *Gault.* Folkestone.

S. Du-Noyeri, Baily, Quart. Journ. Geol. Soc. vol. xxv. p. 361; pl. xv. fig. 4. *Miocene.* Antrim.

Cupressites MacHenrici, Baily, l. c. p. 361; pl. xv. fig. 5. *Miocene.* Antrim.

DICOTYLEDONES.

Mr. Baily refers the leaves found in the Miocene beds of Antrim to *Platanus ?, Fagus ?, Andromeda ?, Quercus ?,* and *Rhamnus ?.* Quart. Journ. vol. xxv. p. 361; pl. xiv.

INCERTÆ SEDIS.

Rhysophycus dispar, Linnars. GEOL. MAG. Vol. VI. p. 403. *Lower Cambrian.* Lugnas, Sweden.

Buthotrephis Harknessii, Nich. GEOL. MAG. Vol. VI. p. 495; pl. xviii. fig. A. *Llandeilo.* Thornship Beck, Shap.

B. (*?*) *radiata,* Nich. l. c. p. 496; pl. xviii. fig. B. *Llandeilo.* Thornship Beck, Shap.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—I. Annual General Meeting, February 18th, 1870.—Prof. T. H. Huxley, LL.D., F.R.S., President, in the Chair. The Secretary read the Reports of the Council, of the Library and Museum Committee, and of the Auditors. The general position of the Society, as evinced by the state of its finances, and by the continued increase in the number of its Members, was stated to be very satisfactory.

In presenting the Wollaston Gold Medal to John Evans, Esq., F.R.S., for transmission to M. G. P. Deshayes, the President spoke as follows:—

I request you to transmit the Wollaston Medal for this year to M. Deshayes, as an expression, on the part of the Geological Society, of the high estimation in which his services to Palæontology and Geology, especially in regard to the classification of the Tertiary formation, are held by the geologists of this country.

Six years ago the Council of this Society demonstrated the interest which it took in M. Deshayes's valuable investigations, by awarding him the Donation-fund. Now that those researches, commenced just fifty years ago, are completed, and the labours of a life devoted to science are crowned by the publication of five great volumes, containing descriptions and figures of all the Mollusca of the Paris Basin, it has seemed to the Council a fitting opportunity for bestowing the highest honour at its disposal upon the pupil, editor, and continuator of Lamarck, and the worthy successor of his great master in the Chair of Natural History in the Muséum d'Histoire Naturelle.

Mr. Evans read the following reply, on behalf of Prof. Ansted, F.R.S., the Foreign Secretary of the Society, who was unavoidably absent:—

I have the honour to acknowledge, on the part of M. Deshayes, the award of the Woollaston Medal, and in forwarding to him this mark of the estimation in which his labours are held among English geologists, I will not fail to communicate the observations you, Sir, as representing the Society, have thought fit to express.

It is much to be regretted that M. Deshayes is not present in person to receive this Medal, and assure you of the extent to which he appreciates it. On three occasions, the first no less than thirty-four years ago, he received the award of the proceeds of the Wollaston Donation-fund to assist him in those long-continued researches of which we have lately received the completion, in the publication of the last volume of the work with which his name will always be connected. Placed in a district rich in an extraordinary degree in fossils of one geological period, he has devoted himself to the study of one important group of these fossils; and how well he has succeeded his recent appointment to the Chair of Lamarck in France, and the award of the Wollaston Medal in England, afford sufficient illustration.

The President then presented the Balance of the Proceeds of the Wollaston Donation-fund to Mr. Evans, for transmission to M. Marie Rouault, Keeper of the Geological Museum at Rennes, in aid of his researches upon the Palæontology of the Devonian and Silurian Rocks of Brittany, and expressed himself as follows:—

The cosmopolitanism of science is well illustrated by the fact that all the honours at our disposal this year are gladly and willingly accorded to foreigners. The Wollaston Medal has gone to M. Deshayes. The Fund has been awarded by the Council to another member of the same great nationality, M. Marie Rouault, who, working under difficulties and discouragements such as those which beset the early life of our own Hugh Miller, has made most important contributions to our knowledge of the fauna of the oldest palæozoic rocks of France.

Mr. Evans read the following acknowledgment on behalf of Prof. Ansted:—

In returning thanks on the part of Monsieur Rouault for the grant of the balance of the proceeds of the Wollaston-fund, I will take the opportunity of saying a few words concerning the nature and extent of the scientific work executed by this hardy and persevering geologist in his own most difficult country.

Monsieur Rouault is one of those men who are independent of, and rise above, all distinctions of class. Self-educated, in the strictest sense of the term, a collector of fossils, because his nature would not allow him to be other, he resembles the lamented Hugh Miller, and our still active and useful countryman, Mr. Peach, the latter of whom attained a similar distinction under very similar difficulties.

Nearly seventeen years ago the valuable collections already in the possession of Monsieur Rouault were presented to the municipality of Rennes, and formed the principal nucleus of a museum then first established. The previous owner then became *Directeur-conservateur* of the Geological and Palæontological Museum of the town of Rennes; and this museum has, since its first establishment, been greatly enriched by the same agency. It is exceedingly rich in local fossils, and contains many type-specimens, some of extreme interest.

The money I receive on the part of M. Rouault will, I am sure, be employed by him in the best interests of science, and will be recognized as a fit acknowledgment of the services he has already rendered to palæozoic geology, and an earnest of work still in progress.

The President then proceeded to read his Anniversary Address, in which he reverted to the subject treated by him in an Anniversary Address delivered in 1862, namely, the distribution and succession of animal forms in time and space. The Address was prefaced by biographical notices of deceased Fellows, including Prof. Brayley, F.R.S.; Dr. Hermann von Meyer; Dr. B. Shumard; Dr. Roget, F.R.S.; Prof. Graham, F.R.S.; Prof. Jukes, F.R.S.; Dr. W. Clarke, F.R.S.; J. W. Salter, Esq.; the Vicomte d'Archiac, &c.

The Ballot for the Council and Officers was taken, and the following were duly elected for the ensuing year:—*President:* Joseph Prestwich, Esq., F.R.S. *Vice-Presidents:* Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S. *Secretaries:* P. Martin Duncan, M.B., F.R.S.; John Evans, Esq., F.R.S. *Foreign Secretary:* Prof. D. T. Ansted, M.A., F.R.S. *Treasurer:* J. Gwyn Jeffreys, Esq., F.R.S. *Council:* Prof. D. T. Ansted, M.A., F.R.S.; William Carruthers, Esq., F.L.S.; W. Boyd Dawkins, Esq., M.A., F.R.S.; P. Martin Duncan, M.B., F.R.S.; Sir P. de M. G. Egerton, Bart., M.P., F.R.S.; John Evans, Esq., F.R.S., F.S.A.; David Forbes, Esq., F.R.S.; J. Wickham Flower, Esq.; Capt. Douglas Galton, C.B., F.R.S.; R. A. C. Godwin-Austen, Esq., F.R.S.; Harvey B. Holl, M.D.; J. Whitaker Hulke, Esq., F.R.S.; Prof. T. H. Huxley, LL.D., F.R.S.: J. Gwyn Jeffreys, Esq., F.R.S.; Sir Charles Lyell, Bart., D.C.L., F.R.S.; George Maw, Esq., F.L.S.; John Carrick Moore, Esq., M.A., F.R.S.; Prof. John Morris; Joseph Prestwich, Esq., F.R.S.; Warington W. Smyth, Esq., M.A., F.R.S.; Rev. W. S. Symonds, M.A.; Rev. Thomas Wiltshire, M.A., F.R.A.S.; Henry Woodward, Esq., F.Z.S.

II. Evening Meeting, February 23rd, 1870.—Joseph Prestwich, Esq., F.R.S., President, in the Chair. The following communications were read:—1. "Additional Observations on the Neocomian Strata in Yorkshire and Lincolnshire, with notes on their relations to the Beds of the same age throughout Northern Europe." By J. W. Judd, Esq., F.G.S.

This paper embodied the results of the author's further study of the Neocomian beds of the north of England, in connexion with those of North-western Germany.

The inland development of these strata in the Vale of Pickering, was described as being greatly obscured by superficial deposits. The beds, however, exposed at Reighton, West Heslerton, and Knapton, were shown to agree, both in physical and palæontological characters, with several of those before described in the cliff section at Speeton.

The Neocomian ironstones of Lincolnshire have, since the date of the former paper on the subject (1867), been extensively opened out by mining operations; and the valuable and instructive sections thus afforded were described in detail. A general sketch was then given of the range and characteristics of the Neocomian strata in Yorkshire and Lincolnshire.

Evidence was next adduced to show that strata of the same age, and remarkably similar in character, had been deposited over a very wide area in northern Europe. Throughout the whole of these districts, however, the Neocomian strata were very inadequately exposed, and afforded no good general sections; and the Speeton Cliff thus acquired an additional interest from the fact that it forms a valuable, and almost the only, key whereby we can correlate the beds over this vast area.

Studying the continental deposits in this manner, by the aid of the Speeton section, the fossiliferous clays of the island of Heligoland were shown to belong to the "Zone of *Ammonites Speetonensis*," *i.e.* the upper part of the Lower Neocomian. The boulders found in the drift deposits of Holland were referred to as evidence of the former wide extension of limestones similar to those of Tealby in Lincolnshire. In Westphalia the sandstones, limestones, ironstones, and clays, so extensively developed in the hills of Bentheim and the Teutoburger Walde, were shown to be of Middle Neocomian age, while certain beds of clay in the same district were referable to the Upper Neocomian. In Hanover the "Hilsthon" of M. Fr. Ad. Römer was shown to be in its upper part Upper Neocomian, and in its lower part Middle Neocomian, the latter passing locally into beds of Oolitic ironstone, sandstones, and limestones, precisely similar to those of the same age in Lincolnshire. The narrow strip of highly inclined Neocomian strata along the northern foot of the Hartz was shown to belong to the same two subdivisions. In Brunswick, however, the Neocomian series was more complete; for underneath some 400 feet of clays, which on palæontological evidence clearly belong to the Upper and Middle divisions, there were certain marly limestones, in places becoming ferruginous, containing an abundant and interesting fauna, which was most unmistakeably that of the *Lower* Neocomian.

It was then pointed out that in northern Germany there was evidence, as in this country, of an unconformity existing between the Upper Cretaceous and the Neocomian, as well as between this last and the Jurassic. Attention was also drawn to the fact that while the Neocomian series was complete in Yorkshire and Brunswick, its lowest member was absent in the intermediate districts, being apparently replaced by the freshwater deposits of the German Wealden.

Discussion.—Mr. Etheridge stated that he had examined sections in Brunswick and Hanover, at Hildesheim, and other places, and confirmed Mr. Judd's results. He remarked upon the occurrence of *Pecten cinctus* in the Middle Neocomian in England and in the Lower Neocomian in Germany.

Sir Charles Lyell noticed the occurrence of anticlinals and contortions in the Brunswick district, and remarked upon the comprehensiveness now ascribed to the "Speeton Clay," and on the correspondence of the phenomena observed in Yorkshire, with those presented in the South of England, in passing from Folkestone to the Isle of Wight. He also mentioned the occurrence of *Ammonites Deshayesii* in the Hastings sand at Punfield, as indicating the marine and Cretaceous nature of that deposit.

The President inquired as to the evidence of the representation of the Lower Neocomian by Wealden deposits in Germany.

Mr. Judd remarked that the Punfield marine band is absolutely enclosed in the Wealden, and that its fossils have an Upper Neocomian character, with a clear affinity to a Spanish series. He regarded the Wealden of North Germany as not strictly contemporaneous with that of England, and stated that the "Hilsconglomerat" in Brunswick was a shore-deposit, but that its correlation with the Wealden was impossible.

2. "On Deep-mining with relation to the Physical structure and Mineral-bearing Strata of the S.W. of Ireland." By Samuel Hyde, Esq. Communicated by R. Etheridge, Esq., F.G.S.

The author described the general structure of the country in the south-west extremity of Ireland, which he stated to consist of a series of rocks analogous to the "Killas" of Cornwall, and belonging to the upper part of the Lower, or the lower part of the Upper Devonian series. He combated the opinion which had been expressed by the late Professor Jukes, that copper ores would not be found in the district in sufficient quantities to make mining there a remunerative process. In support of his thesis, he cited the Bearhaven mines, established about fifty years ago, the Allitries and Ballycummisk mines, and the Coosheen mine. He stated that in the Ballycummisk mines a depth of 200 fathoms has been reached, and that some of the shafts at Bearhaven are much deeper. These deep workings were said to yield large returns of ore. In opposition to the opinions stated by the late Professor Jukes, the author maintained that the copper lodes were of the same nature as those of Cornwall, and he described them as running in a similar direction, namely, 10°–25° N. of E. From the similarity in the geological constitution of the country, and in the direction of its mineral veins, the author was inclined to infer a former continuity between the south-western promontories of the islands of Great Britain and Ireland.

Discussion.—Mr. David Forbes protested against the notion that the Devonian strata themselves were metalliferous, the veins being of much later date,—in the present case Post-carboniferous. He maintained that there was no valid reason for supposing that the veins became unproductive with increased depth, and opposed the notion that they had been filled in by segregation from the surrounding rock. He alluded to the use of spectroscopic analysis in such inquiries, and remarked that as no trace of copper is to be found in the rock, even immediately adjacent to veins, we should have to admit, on the hypothesis of segregation, that the rock must originally have contained precisely the amount of metal segregated in the veins.

Mr. Etheridge agreed with Mr. Forbes as to the date of the filling in of the veins. He also maintained the justice of correlating the rocks with those of the Cornish area.

Mr. Hyde briefly replied.

Geological Society of London.—III. March 9th, 1870.—Warington W. Smyth, Esq., F.R.S., Vice-President in the chair. The following communications were read:—1. "On the structure of a Fern-stem from the Lower Eocene of Herne Bay, and on its allies, recent and fossil." By W. Carruthers, Esq., F.L.S., F.G.S. The author described the characters of the fossil-stem of a Fern obtained by George Dowker, Esq., F.G.S., from the beach at Herne Bay, and stated that in its structure it agreed most closely with the living *Osmunda regalis*, and certainly belonged to the Osmundaceæ. The broken petioles show a single crescentic vascular bundle. The section of the true stem shows a white parenchymatous medulla, a narrow vascular cylinder, interrupted by long slender meshes, from which the vascular bundles of the petioles spring, and a parenchymatous cortical layer. The author described the arrangement of these parts in detail, and indicated their agreement with the same parts in *Osmunda regalis*. He did not venture to refer the Fern, to which this stem had belonged, positively to the genus *Osmunda*, but preferred describing it as an *Osmundites*, under the name of *O. Dowkeri*. The specimen was silicified, and the author stated that even the starch grains contained in its cells, and the mycelium of a parasitic fungus traversing some of them were perfectly represented. Its precise origin was unknown; it was said to be probably derived from the London Clay, or from the beds immediately below.

Discussion.—Mr. W. W. Smyth, in calling on those present for remarks on the paper, commented on the very remarkable manner in which the minutest details of the original plant had become silicified.

Mr. Etheridge mentioned the discovery of fossil fern-stems of somewhat similar character at Bromsgrove.

Prof. Ramsay suggested the possibility of the fossil having been derived from a bed even higher than the Thanet Sands. He thought the rarity of such delicate structures being perfectly preserved by silicification not so great as might at first sight appear, for in Antigua and elsewhere vegetable forms had been converted into flint as completely and distinctly.

Mr. Woodward cited the hotsprings in the Island of St. Michael as converting portions of vegetables still growing into flint. He had heard, from the agent of Sir Woodbine Parish, of the ends of piles driven into the beds of rivers in Paraguay and elsewhere in South America having been converted into flint in the course of thirty years, but had not yet seen them.

Mr. Jenkins inquired whether the *Osmundæ* from different formations offer any evidence of the climate under which they lived. He thought that where vegetable structures were perfectly preserved in flint, the process of silicification had gone on but slowly; but this fell more within the province of the chemist than of the geologist.

Mr. Hulke suggested the possibility of the fern having contained a certain amount of silica while still living.

Prof. Morris referred the fossil to the Thanet Sands. He thought that the silica in fossil coniferous and endogenous wood varied in character, and this might throw some light on the process of conversion. He considered that objects containing phosphate of lime, and those containing carbonate, were subject to different processes of silicification.

Mr. Whitaker was strongly of opinion that the fossil had been derived from quite the upper part of the Thanet Sands.

Prof. Duncan called attention to the process of silicification as exhibited by the Antiguan corals, in which one highly insoluble mineral had been replaced by another almost as insoluble.

Mr. Carruthers, in reply, did not think that anything could be predicated as to climate from extinct species; if this were attempted, a similar error to that with regard to the climate under which the fossil Elephants were supposed to have lived, might be repeated. Existing Osmundaceæ contained no silica in their structure. The peculiarity of the fossil under consideration was the preservation of the contents of the cells, even to the starch which is so readily decomposed. The difficulty of accounting for the replacement of soft vegetable matter by hard mineral silica, seemed to him great.

2. "On the Oolites of Northamptonshire." By Samuel Sharp, Esq., F.G.S.

The author stated that his ultimate purpose was to describe severally the Oolitic beds occurring in the Northampton district, in the more northerly parts of the county, and in the neighbourhood of Stamford; to exhibit fossils gathered from each locality, and to correlate the several series, and thus to endeavour to establish the character and sequence of the Oolites of this Midland district. He anticipated, however, that the publication by the Geological Survey of their maps and memoir of North Northamptonshire (the work of Mr. Judd) would intervene, and might render superfluous the carrying out this work in its entirety; but in the meantime he submitted his first part, "The Oolites of Northampton and Neighbourhood."

The author stated that there were four areas within a comparatively small space in which the whole of the beds occurring in each, from the Great Oolite down to the Upper Lias (inclusive), were accessible. These were situated at or about:—1, Kingsthorpe; 2, Northampton; 3, Duston; 4, Blisworth. The Oolitic beds in these several areas were described in detail, the beds of the Northampton Sand (as comparatively little known) being those to which the greatest interest attached. These he proposed to class in three divisions—the "Upper," the "Middle," and the "Lower" Northampton Sand.

The individual beds of the several localities were shown to vary considerably; but collectively they would present the following general section, the maximum thicknesses being given in feet:—

		Feet.
GREAT OOLITE.	A. White Limestone, disposed in beds of from a few inches to about 3 feet in thickness, much fissured, and varying in character, and containing characteristic Great Oolite fossils	25
	B. Blue and grey clay, dug for brick-making, with a ferruginous band at base, and Great Oolite fossils	15

	[Line of unconformity.]	
Upper.	C. White or grey sand, more or less coherent, and with occasional ferruginous stains, sometimes quarried for building-stone. A plant-bed is usually found in this sand	12
Middle.	D. A series of very variable beds, composed sometimes of ferruginous sandstone in thin layers, which overlie calcareous beds containing shelly zones, false bedding being frequent. Sometimes the whole section consists of calcareous rock with false bedding; sometimes it presents a series of beds of compact ferruginous sandstone, with no fossils. In one instance the entire section consists of white sand and sandstone, with no fossils	30
	Coarse Oolitic or subcrystalline Limestone, with fossils, overlying a calcareo-arenaceous slate, like Colleyweston Slate	4
Lower.	E. Beds chiefly consisting of Ironstone, containing *Rhynchonella variabilis* and *R. cynocephala*, and *Ammonites bifrons* at the base	35

This general section, the author stated, might be accepted as a ypical section of a considerable portion of the county of Northmpton.

In his concluding remarks the author referred to the great limetone which marked the country about Stamford, and traversing utland, attained its greatest thickness in Lincolnshire. This imestone was proved by its palæontological contents to be Inferior olite; and its place, with reference to the beds described in the aper, was shown to be in the interval (marking the line of unconrmity) between B and C of the general section. It thus tended confirm the statement of the author that the line of division tween the Great and the Inferior Oolite in the neighbourhood of rthampton occurred at that point.

The paper was illustrated by the exhibition of a large collection fossils from the several areas, including some new species, promit among which was a new Starfish, named, in compliment to the or, "*Stellaster Sharpii*," by Dr. Wright, F.R.S.E., F.G.S., and ribed by him in a Note appended to this paper.

scussion.—Mr. Smyth commented on the great value of careful observations by geologists, such as those brought before the Society by Mr. Sharp.

. Etheridge pointed out how a few years ago it was supposed that hardly a was to be found in these Northampton beds, and that they all belonged to the Oolite, and not to the Inferior, an error in which the Geological Survey had . The district was, however, now being resurveyed under the new light on the character of the rocks by the extensive quarrying which had taken uring the last few years, and which had afforded the opportunities so judiciously by the author of the paper, who had placed the order of succession and the r of the Northampton Beds beyond dispute.

Morris had found a difficulty in reconciling the phenomena of the eastern and Oolitic areas, but considered that the key of the arrangement was to be the district between Northampton and Stamford.

arp briefly replied.

CORRESPONDENCE.

RESTORATION OF DIMORPHODON.

Haven't they prolonged the wrong claws, or toes, or fingers, , Plate IV.? George Greenwood, Colonel.

d Park, Alresford, March 1, 1870.

[Colonel Greenwood is quite correct in his criticism. The artist has given such a twist to the prehensile fingers of the wing in Fig. 2 as to convey the idea that the expanded wing-membrane is supported on the elongated thumb or first digit instead of its little finger, as shown clearly enough in the skeleton, Fig. 1, Plate IV.—Edit.]

DENUDATION OF THE LAKE DISTRICT.

Sir,—Mr. Mackintosh seems to have somewhat mis-read one part of my article on "The Denudation of the Lake District," in the Geological Magazine for January, p. 14. I nowhere stated the probability "that the sea, during the Glacial submergence, was an immovable frozen mass." J. Clifton Ward.

Clapham Common, March 11, 1870.

Buried Sea-cliffs *versus* Faults.—While this question is afloat, Mr. D. Mackintosh would beg to re-direct the attention of Geologists to a well-known spot in the railway-cutting near Uphill (Weston-super-Mare), where the Upper Triassic and Rhætic strata terminate cleanly and abruptly against an overhanging wall of Carboniferous limestone rock, without any sign of displacement except a slight dip towards the limestone—so far as he can recollect. Some years ago he felt a great difficulty in understanding how the phenomenon could have resulted from a fault.

Carlton Hill, Leeds.

ON THE OCCURRENCE OF TOPAZES IN LUNDY ISLAND.

Sir,—I believe it is not generally known to Mineralogists that Topazes occur in the Granite of Lundy Island. A small piece of quartz, to which three topazes are attached, which was brought from that locality, is in the collection of the late Dr. Alfred Day, at Clifton: also a detached crystal, which was obtained by Mr. Robert Etheridge. The crystals are small and of a pale colour, not unlike those found in the Mourne Mountains, Co. Down. S. G. Perceval.

February 24, 1870.

The Geological Collection in the Prague Museum has much increased of late, owing to the vigorous labours in the field by the Committee of Exploration. Of chalk fossils the Museum contains more than 6,000 specimens from 140 localities. Dr. Fritsch hopes some English Geologists will visit and examine the collection. A new entire Scorpion has been discovered in the Coal-measures at Prahys, and a new Saurian in the Permian rocks near Pilsen, which Dr. Fritsch hopes shortly to figure and describe.

ERRATA.

In the February number, 1870, page 79, line 9 from top, erase *Graptolitidæ*.
" " " " " " 12 " for *pusillus* read *putillus*.
In the March number, Glasgow Geological Society's Reports, page 139, line 20 from top, for *inner* read *outer*.
In the March number, in Mr. Scrope's article on Lavas, page 104, line 14 from foot of page, for *silver* read *silica*.

G Poulett Scrope

THE
GEOLOGICAL MAGAZINE.

No. LXXI.—MAY, 1870.

ORIGINAL ARTICLES.

EMINENT LIVING GEOLOGISTS.

I.—George Poulett Scrope, Esq., F.R.S., F.G.S.

(With a Portrait.)

George Poulett Scrope was born in London in 1797, is the second son of J. Poulett Thomson, Esq., of Waverley Abbey, Surrey, the head of the eminent mercantile firm of Thomson, Bonar, and Co., of London and Petersburg, and was educated at Harrow and St. John's College, Cambridge. During his undergraduateship he passed the winter of 1816-17 at Naples, with a part of his family, where he was struck by the phenomena of the neighbouring volcano, then in almost permanent though moderate activity. Returning to Naples in 1819, he renewed his study of Vesuvius and the volcanic territory of the Campagna; and, in the spring of 1820, made the tour of Sicily, visiting Etna and the Lipari isles. Having by these opportunities been led to take much interest in the phenomena of volcanos —at that era much misunderstood and undervalued by the rising schools of geology, both in England and on the Continent, where the doctrines of Werner were still in the ascendant—Mr. Thomson (who, on his marriage in 1821, had assumed the surname of Scrope) passed the summer of that year in a close study of the extinct volcanos of Central France, and collected there the materials for the volume, published by him some years later (in 1827), "On the Geology and Extinct Volcanos of Central France"—a work which has been ever since generally accepted as the best authority as to this interesting district.

From France Mr. Poulett Scrope proceeded to Italy, where, after visiting the Euganean Hills and other volcanic districts of Northern Italy and of the Roman territory, he reached Naples once more, in the beginning of October, 1822, fortunately just in time to witness the great paroxysmal eruption of that month, which left Vesuvius lowered in height by some 600 feet, and transformed from a solid cone, with a nearly flat, rough plain at the summit, into a hollow crust or casing, as it were, still outwardly cone-shaped, but pierced internally by a vast crater, a mile in diameter and nearly 2,000 feet deep, which had been torn through the heart of the mountain by powerful continuous explosions of twenty days' duration. The study of this stupendous example of volcanic energy, and of its effects, impressed Mr. Poulett Scrope with those opinions on the true character and mode of action of volcanic force which distinguish his views on this subject from those of the greater number of writers who have treated upon the same matters, but who possessed a less fortunate combination of opportunities for the direct personal observation of the phenomena, and the formation of a sound judgment as to their real nature.

Mr. Scrope contributed to *Brande's Journal of Science* a short account of the great eruption of 1822, with a drawing of the crater as it appeared immediately after.[1]

In the summer of 1823 he spent some time in the examination of the volcanic region of the Upper and Lower Eifel, the Siebergebirge, &c., and subsequently sent a detailed description of them to the *Edinburgh Journal of Science.*[2] Returning to England, he naturally sought the society of fellow-labourers in the field of Geology, became a member of the Geological Society (1824), and in the next year was elected one of its Secretaries, having for colleague the then Mr., now Sir Charles Lyell, with whom a community of ideas on the expediency of taking the existing agencies of change on the earth's present surface as the only sure guide to its past history formed a bond of intimacy and mutual regard. The drawings which Mr. Scrope had brought with him from Central France, and which were freely shown to his Geological associates, and the explanation they afforded, obvious to the eye, of the true character of volcanic phenomena, up to that time more or less hotly disputed, naturally attracted much attention. In 1824-5 Mr. Scrope published the first edition of his work "On Volcanos, the Character and Probable Causes of their Phenomena, and their Connection with the Present State and Past History of the Earth," &c. This work, of which a second and much improved edition was published by Longmans in 1852, was not at first very favourably received among geologists—owing, no doubt, to a faulty arrangement of the subject, the theoretical, and in many respects novel, views of the author being put forward in somewhat too dogmatic a form, without being preceded, or even sufficiently illustrated, by a statement of the facts and observations on which they were based, and which had been collected by the author's close and long-continued study of volcanic regions, made, as we have briefly stated, in the preceding years. It must be remembered, too, that at that period geologists were not yet even agreed upon such elementary ideas as the volcanic origin of Basalt. No wonder, then, that a work which professed to teach that not merely all Basalts, but the Trachytes and Porphyries, Syenites, and even Granite itself, were varieties of Lava, and at the time of their protrusion at an intense temperature contained a certain quantity of *water*, interstitially combined with their mineral elements, was met by many with distrust, by some even with ridicule. A few years later, however, the justness of Mr. Poulett Scrope's ideas on these and other points of subterranean agency began to be acknowledged; and even in 1826-7, when his volume "On the Geology and Extinct Volcanos of Central France" issued from the press, illustrated by an Atlas containing faithful copies of elaborate drawings made on the spot, a different opinion began to be formed as to the authority of his earlier work. Lyell and Murchison followed his footsteps in Auvergne, the Cantal, and the Haute Loire, and on their return testified to the accuracy of his drawings and descriptions of the facts there exhibited, as well in respect to the volcanic formations as to the remarkable proofs of the immense amount of denudation effected by sub-aerial, or atmospheric, agency. In 1827, a review of his work on Central France appeared in the *Quarterly*,[1] from the pen of Mr. Lyell, in which full justice was done to the author, and the general attention of geologists attracted to the subject. One passage in particular, from this able review, we will insert here, relative to the theory of *denudation*:—"We consider Mr. Scrope's work the most able that has appeared since Playfair's illustration of the Huttonian theory, in support of the opinion that "valleys have been shaped out progressively by the action of rivers, or of such floods as may occur in the ordinary course of nature" (p. 477). Two or three years later (1830), Mr. Lyell published the first edition of his great work, "The Elements of Geology," in which the doctrines of Hutton and Playfair, as to the influence on the earth's surface of both the igneous and aqueous agencies of change were so ably and fully advocated; and it is not unreasonable to suppose that, in the interval, his views on theoretical geology had been considerably influenced by those which had been previously enounced by Mr. Scrope, and the facts and arguments adduced by him in their support. However this may be, Mr. Scrope, in his turn, reviewed the new and interesting volume of Mr. Lyell, in the same periodical, the *Quarterly* (vol. xliii., p. 411), and expressed both admiration for and agreement with the author on almost all points—except, perhaps, that of the doctrine of absolute *uniformity* in the series of geological changes (see p. 464)—a doctrine still, we believe, advocated by Sir C. Lyell, and still questioned by other eminent geologists.[2] In 1826 and 1827 Mr. Scrope contributed to the Transactions of the Geological Society two papers, with copious illustrations, "On the Phlegræan Fields, near Naples," and "On the Ponza Islands." (Geol. Trans., 2nd ser., vol. ii. and vol. vi.)

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[1] Journal Royal Inst., vol. xv., p. 175.

[2] Edin. Journal of Science for June, 1826.

With regard to the controversy between the rival Geological Schools of Uniformitarians and Evolutionists, it will be seen by those who may look into the two quarterly articles above referred to, upon Sir Charles Lyell's principles, that, although from a very early period a believer in the Uniformity of Causation, Mr. Scrope has always differed somewhat from the Lyellian doctrine, as to the absence of any indications in the series of geological facts of Progressive Development.

Perhaps even in the present day the argument has not been more tersely summed up than we find it in the concluding sentences of the Review Article of 1835, of which we can only afford space for one paragraph. "The idea of progressive development does not (as Mr. Lyell seems to think) involve any doubt as to the permanence of the laws of nature. The theory, for example, of the gradual refrigeration of the globe does not suppose any deviation from the existing laws of heat, light, or gravity. No one disputes the constancy of these. Mr. Lyell's real theory is that there has been no progressive variation in the intensity of the forces which operate on the earth's crust, but that a cyclical succession of such changes, of equal amount in equal periods, has been going on through all time, so far as geology enables us to explore its abysses. The fact may be so. We do not affirm the contrary in any positive spirit. But Mr. Lyell must be content to join issue with his opponents on the point, under the disadvantage of all analogy being against him; from which, as we have shown, it is presumable, *à priori*, that the series of geological mutations to which the earth is subject, is a progressive, not a stationary or recurring series—that our planet, like every individual form within it, is subject to the law of integration and disintegration; has had a beginning, and will have an end."

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[1] Quart. Rev., vol. xxxvi., p. 437.

[2] See Anniversary *Address to the Geol.* Soc. Lond. 1869, by Prof. Huxley.

At this period (1830) Mr. Poulett Scrope had for some years settled down in the ancient family seat of the Scropes of Wiltshire (Castle Combe), and, acting as a magistrate, had been strongly impressed by the pauperized condition of the agricultural labourer. Hence he was led more and more to neglect Geology for the more practical subjects of Political or Social Economy. In this line of thought, a long series of pamphlets, reviews, and other contributions to the periodical literature of the day, were published by him—bearing especially upon the necessity of a Revision of the English Poor Law, and its extension in an improved form to Ireland and Scotland; on Banking, the Currency, etc. His brother, Mr. Poulett Thomson (afterwards created Lord Sydenham), had been for some years in Parliament, and to Mr. Scrope, the passing of the Reform Bill in 1832, of which he had been long a zealous advocate, afforded an opening for a similar position, which would enable him to further his long entertained economical opinions in the Legislature. In 1833 he was elected one of the members for the Borough of Stroud, one of the newly formed Constituencies, lying at no great distance from his Wiltshire residence, and for this Borough he continued to sit in Parliament up to his retirement in the year 1868, a period of 35 years. We do not attempt to follow his public career, but may mention that in 1835 he published a small volume on Political Economy—the leading object of which was, in his own words, to show that "so long as the cultivated portion of the earth's surface bears as now but a fractional proportion to its cultivable area, any permanent want of subsistence felt by man can arise only through his own wilful neglect of the means placed at his disposal by Providence—in opposition to the narrow Malthusian doctrine which teaches the necessity of artificial restraint on the increase of *population within* the limits of each state, as the only means of preventing want, and even famine. Mr. Scrope took a prominent part in the discussions on the Reform of the Poor Laws in England, and their extension to Ireland and Scotland—measures long advocated by him—in furthering the adoption of free-trade principles, and generally of all social reforms. His interest in Geology, however, especially in that branch of the subject which he had made his special study, had not altogether subsided. In 1835 he reviewed in the Quarterly the third edition of Lyell's Principles (Quart. Rev. vol. xliii. p. 406); and in 1856 he read before the Geological Society a paper on the liquidity of Lavas, and the mode of formation of Volcanic Cones and Craters (Geol. Soc. Journal for 1856, p. 337), in which he combated the famous Elevation Crater theory of MM. Humboldt, Von Buch, and Elie de Beaumont, showing that it had originated in a mistaken view of the origin of the "raised plain" around the Volcano of Jorullo in Mexico, taken by the first of these authors—a view which Mr. Scrope himself had opposed and exploded, in a special notice printed in the appendix to his work on Volcanos, as early as 1824-5, but which, notwithstanding, had since that date continued to spread, "under the influence of a few great names," until it had thrown into complete confusion, especially on the Continent, all current notions upon the true mode of action of Volcanic energy.

In February, 1859, Mr. Scrope recurred to this subject in a second paper read before the Geological Society—induced by the fact of the publication in the interval of M. de Humboldt's "Cosmos," throughout the whole of which work the theory of Elevation Craters, and the upheaval in mass of all volcanic mountains, was upheld, to the utter confusion of all just ideas on the nature of volcanic action (See The Geologist, vol. ii. p. 124).

In 1862 Mr. Scrope superintended a new edition of his work on Volcanos, with an enlarged description of all the known Volcanos and volcanic formations of the globe, in which the faults of style and arrangement of the earlier edition already mentioned were avoided, while retaining all the original views, many of which—especially that on the important part played by water in the production of the igneous rocks—had been in the meantime confirmed by the experiments of Sorby, Scheerer, Daubree, and others.

The "Geology of Central France" had already passed through a second edition (Murray, 1852), and both works had been printed in a French translation at Paris.

From that time to the present Mr. Scrope has continued to contribute occasional papers to the several scientific periodicals—among them the following:—"On the probable influence, upon the internal structure of rocks, of the mutual friction of their component parts, when forced into motion under extreme pressure" (read before the Geological Society, May 12th, 1858, and printed in The Geologist, vol. i., p. 362, with an illustration). In this paper Mr. Scrope contended that the foliation of the metamorphic schists, no less than the "cleavage" of the finer slates, was owing to the "squeeze" of their *crystalline* or semi-crystalline particles (unequi axial in form), while the matter composing them was in a semi-liquid or viscous state, and subjected to extreme and oblique pressures—a view which he had been led to form and declare, as early as 1824, by a study of the laminated pearlstones and trachytes of the Ponza Isles.[1]

"On the Causes of Earthquakes." (Geologist, vi. p. 455.)
"On the Origin of Valleys." (GEOLOGICAL MAGAZINE, Vol. III. p. 192.)
"On the Origin of Hills and Valleys." (*Ibid.* p. 241.)
"On the Terraces of the Chalk Downs." (*Ibid.* p. 293.)
"On Atmospheric Forces." (*Ibid.* p. 379.)
"On the Cause of Faults and Contortions of Strata." (*Ibid.* Vol. V. p. 339.)
"On the Supposed Internal Fluidity of the Earth." (*Ibid.* Vol. VI. p. 145.)
"On the Influx of Water as the Cause of Volcanic Eruptions." (*Ibid.* p. 196.)
"Review of MM. Dollfus and Montserrat's Geology of Guatemala." (*Ibid.* p. 455.)
"Review of Baron Richthofen's System of Volcanic Rocks." (*Ibid.* p. 510.)
"On the Pretended Raised Sea-beaches of the Inland Slopes of England and Wales." (*Ibid.* p. 535.)
"On Lavas." (*Ibid.* Vol. VII. p. 100.)

In these papers Mr. Scrope, it will be seen, confined himself to the vindication of opinions, already put forward by him in his larger works, upon the phenomena of subterranean or volcanic agency, and also on the influence of "subaerial"—that is to say, atmospheric—agencies in moulding the surface of the earth. In some of these he may, perhaps, be charged with an impatience of what he considered the mischievous fallacies of the writers he opposes, as, for instance, while combating the "upheaval" doctrines of Humboldt and Elie de Beaumont, or the views on "exclusively marine denudation," professed by Mr. D. Mackintosh. But, if this charge be true, it may fairly be attributed to the earnestness with which, as a student of nature and a propagator of scientific truth, he looks on persistence in a false theory, after its fallacy has been fully exposed, as "not merely a fault, but a crime," from its baleful effect in checking the progress of true science. Mr. Scrope, it will be seen, has not allowed himself to be led from the line of geological study which he first traced for himself in early life—namely, that of the igneous and aqueous agents of change, discoverable on the surface of the globe, and their influence on its past history. Commencing his observations at a period when the Huttonian theory was absolutely discountenanced and discredited (1817-23), he perceived intuitively, and proclaimed in his first publication, that one of the primary tasks of the geologist is to obtain "a knowledge of the processes which are in continual or occasional operation upon the surface of our planet, and the application of these laws to explain the appearances discovered by our geognostical researches" into the character of its rock formations, "so as from these materials to deduce conclusions as to its past history" (Preface to first edition of Volcanos, 1825). With this object he devoted himself to an examination of the phenomena of volcanos, both active and extinct, taking note, at the same time, of the effects of atmospheric action on the surface of subaerial land; and the facts he collected and the views he propounded on these points have received confirmation, as time flowed on, from nearly all the most trustworthy of his contemporaries.

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[1] See his paper on the Ponza Islands, read before the Geological Society in 1827 (*Geol. Trans. Ser.* ii. vol. ii.)

So lately as February, 1867, the President, Mr. Warington W. Smyth, in the name of the Geological Society, conferred upon Mr. Poulett Scrope the highest honour at the disposal of that body, namely, the Wollaston Gold Medal, in recognition of his researches into the nature and origin of volcanos; with which line of investigation his name will always be indissolubly connected.

II.—ON THE SURFACE-GEOLOGY, DENUDATION, AND "FORM OF THE GROUND" OF BELGIUM.

By H. M. JENKINS, F.G.S., Secretary of the Royal Agricultural Society.

THE review of my "Report on the Agriculture of Belgium," which appeared in the last number of the GEOLOGICAL MAGAZINE, illustrated by a reprint of the map which originally accompanied it in the "Journal of the Royal Agricultural Society" (2nd series, vol. vi., part 1), has induced me to offer some further remarks on the surface-geology of that kingdom while the subject is still fresh in the recollection of the readers of this Magazine.

A mere glance at the map is sufficient to impress the geologist with the remarkable parallelism existing between the boundary lines of the surface-deposits and certain contour-lines, which show what the late Professor Jukes delighted to call the "form of the ground." The accompanying section, drawn from Ostend, on the north-west, past Ghent, and through Nivelles, Namur, and Dinant, to near Longwy, in the south-east, will illustrate my meaning. Ostend is situated on the seaboard margin of a Polder-plain, the alluvial deposits which constitute its environs having been reclaimed from the sea chiefly within the historic period. Proceeding in a south-easterly direction, the Polder alluvium is succeeded by a broad belt of sand (the Campine sands), which, although it appears almost a plain to a casual observer, has in reality a slight inclination, so that at about two-thirds of the distance across it we reach a height of 75 feet above the sea-level; but, except in the Campine, at the extreme east of Belgium, this sandy zone never attains a much greater elevation. The perfect inclination of this zone is interrupted, and its gradual rise is masked, by the valleys of several tributaries of the Scheldt (Escaut), as well as by the wide and deep valley of that river itself.

South-east of the sandy zone we enter upon a broad belt of loam, generally known as the Limon de Hesbaye, or Loess, and immediately the gradient of the surface-incline increases to a very remarkable extent. While previously the gradient has not been more, and has generally been less, than 75 feet in 20 miles, or less than three inches per mile, we now find the line of 150 feet elevation running at a regular distance of about three miles from that of 75 feet, across two-thirds of the kingdom of Belgium. We have here, therefore, the following noteworthy phenomena:—(1.) A gradient of from 20 to 25 feet per mile, instead of one of 3 inches; (2.) The parallelism of the lines of 75 and 150 feet elevation; and (3.) The parallelism of these lines with the line of junction of the Campine sands and the Limon de Hesbaye.

South-east of the 150 foot contour-line the inclination of the surface again becomes comparatively gradual, though somewhat irregular and more interrupted than was the case in the sandy zone; but from the 150 foot line to the valley of the Meuse, a distance of about 60 miles, the rise is not more than about 350 feet, the north bank of the river having an average height of about 500 feet above the sea level. This rise indicates a gradient of less than six feet per mile, or not much more than one-fourth of that just noticed—a fact sufficiently remarkable when placed in contrast with the former abrupt declivity, and with what is seen on the south bank of the river valley.

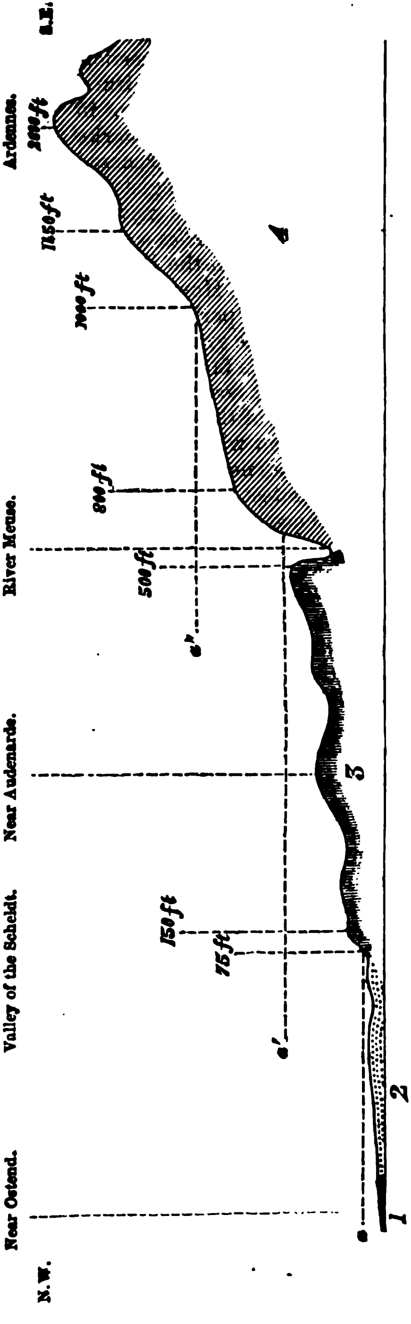
The line of 600 feet elevation runs about two or three miles to the south of the Meuse valley, and is succeeded southwards, at a mean distance of about four miles, by the line of 800 feet elevation, the gradient between these two lines being, therefore, as high as 50 feet per mile. The succeeding flatness, as already described in the previous cases, is once more seen south of the 800 feet line, for it requires a journey of about 20 miles (except in the extreme east of the Ardennes) to reach the line of 1,000 feet elevation, thus showing that the gradient has fallen to about 10 feet per mile. South of this "inclined plane" we meet with another and still more abrupt gradient, and then reach the broken plain and the isolated eminences of the Higher Ardennes.

The significance of these facts to the geologist and the physical geographer appears to me so obvious that I shall mention but very briefly the conclusions which they forced upon my mind. In the first place, the Limon de Hesbaye rarely crosses the gorge which forms the Meuse valley. I have, therefore, for agricultural purposes, mapped all the tract of country south of the Meuse as "Strong Plateau-land;" but geologists know very well that the Condroz and the Ardennes, which comprise that tract, consist of certain Palæozoic rocks, overlain in places by patches of drift (*Cailloux Ardennais*) near the numerous watercourses. This drift, containing rocks of Ardennes origin, is also found beneath the loam in the Hesbaye and beneath the sand in the Campine.

North of the Meuse, and at a lower level, therefore, is the more or less broken plateau, having the Limon de Hesbaye as its surface-deposit; and north of this loam, at a still lower level, is the plateau composed of the Campine Sands. This terrace arrangement, in reference to the geological age of the surface-deposits of Belgium, seems to me capable of but one interpretation—namely, that the Ardennes drift (*Cailloux Ardennais*) is the oldest of the deposits, the Limon de Hesbaye the next in succession, and the Campine Sands the youngest of all, with the exception of the Polders, which we know to have a historic date.

The Campine Sands were regarded as contemporaneous with the Limon de Hesbaye by M. Dumont, and as older than it by M.

SECTION FROM THE BELGIAN COAST TO THE HIGHER ARDENNES (150 MILES).



1. Polders. 2. Campine Sands 3. Limon de Hesbaye (Loess). 4. Palæozoic Rocks.

a a′ a″ Planes of Marine Denudation.

d'Omalius d'Halloy; but I venture to think that the physical relations of the deposits prove the higher antiquity of the Limon de Hesbaye. The importance of the question, however, should lead to further investigations than my agricultural engagements left me time to prosecute. Mr. Godwin-Austen, in his paper "On the Kainozoic formations of Belgium," remarks[1]:—"The age of the Campine sands has been very often discussed. They are now very generally referred by Belgian geologists to the *Système Diluvien* Though the true Campine sand has never been found to contain animal remains of any kind, it *overlies* a surface with *Elephas primigenius*. It is certainly older than the Polder mud deposits and their equivalents, the peat growths. However, there may still be a great range between these extreme periods. In like manner, the Loess (Limon de Hesbaye) *overlies* the gravel beds in which the fragmentary remains of the great Pachyderm fauna occur. Both the Campine sands and the Loess are subsequent accumulations to the Ardennes quartz pebbles; but the occurrence of these pebbles at the base of both does not necessarily connect them with either, but it suggests that these two accumulations must be nearly of the same age, and such, it seems, was M. Dumont's latest view."

The occasional occurrence of freshwater and land shells (*Succinea* *Pupa*, &c.) in the Limon de Hesbaye has led to the opinion that the whole mass is of freshwater origin. I find it difficult to subscribe to this view, and still more so to that which ascribes a contemporaneous formation to the Loess and the Campine sands; as in that case the sand must have been deposited in the *deeper* water!

With reference to the causes which have produced the present "form of the ground" in Belgium, these terraces seem to me to demonstrate the truth of Professor Ramsay's idea of "planes of marine denudation,"[2] so far, at least, as that country is concerned; and in the accompanying section I have shown by a dotted line where I conceive the planes of marine denudation left the surface of the country to have its present physiognomy chiselled out by the force of subaërial agents.[3]

The delineation of the contour lines on a map of the surface geology appears a most important adjunct. In the map of Belgium, it is instructive to observe the remarkable coincidence in the "behaviour" of the contour lines and in that of the geological boundaries, and especially how they similarly become squeezed together in the east and widen out in the west. The whole country is higher and less diversified in the east than in the centre of the Kingdom; but in the extreme west it begins to rise again, so that if a certain portion of France had been included, the map would probably have shown the existence of a great surface-trough with a nearly north and south direction.

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[1] Quart. Journal Geol. Soc., vol. xxii., p. 250.

[2] A somewhat similar view of another region has been proposed by Mr. G. A Lebour to explain the surface-features of Western Brittany. (See Geol. Mag Vol. VI. 1869, p. 442.)—Edit.

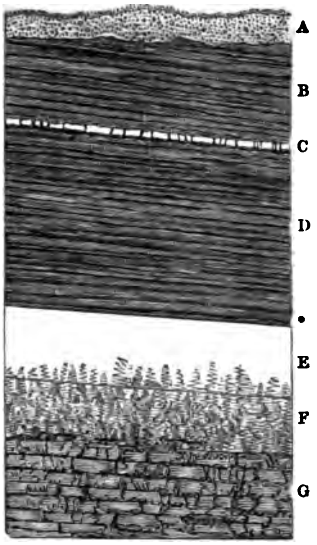
[3] May we not regard the far greater diversity (*i.e.* the more denuded character) of the surface covered by the Limon de Hesbaye than of the Campine sand region as an additional piece of evidence in favour of the previous denudation of the former region. The eminences in the loamy region are numerous, and not unfrequently rise to a height of from 300 to 400 feet above the neighbouring valleys, while in the Campine sand district a difference of level of 50 feet cannot be seen except in the extreme east—the true Campine.

III.—ON THE OCCURRENCE OF THE RHÆTIC BEDS IN NORTH SHROPSHIRE AND CHESHIRE.

By GEO. MAW, F.G.S., F.L.S., etc.

THE outlying mass of Lias on the borders of Shropshire and Cheshire is so thickly covered with Boulder-drift, that its line of boundary throughout almost its entire circumference is very obscure. The direct sequence from the underlying Keuper Marls is scarcely anywhere visible, and I believe no record of the occurrence of the Avicula contorta zone has hitherto been published.

FIG. 1.



Section near Audlem Mill.
• Junction not visible.

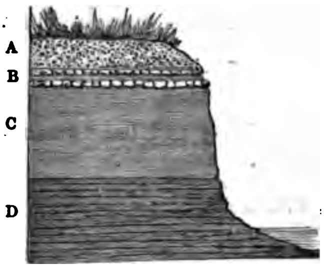
About three years ago I noticed near Audlem an exposure of fissile shale, closely resembling the "Paper-shales" of the Garden-cliff and other Gloucestershire sections, and more recently procured a small series of fossils confirming their identity with the Rhætic beds.

The strata represented in the accompanying section, Fig. 1, occur in a lane-cutting, near Audlem Mill, immediately to the south of Audlem Railway Station. They dip about 7° to the east, and include the following beds:—A, drift of variable thickness; B, about 8 feet of black fissile shales (Paper-shales); C, hard band of rock, about 6 inches thick; D, a repetition of black flaky shales, about 15 feet thick, passing downwards into a light buff marl, E, 6 feet thick; but the junction is obscured by the Railway Bridge. The buff marl graduates into soft red Keuper marls, F, about 5 feet thick, succeeded by hard variegated marl, G, exposed in the bed of the brook.

The black shales, D, abound with *Avicula-contorta*, and Mr. Etheridge, who has kindly examined the fossils for me, has also determined, in the shales, D, *Pullastra arenicola* and *Cardium Rhæticum*; and in the bed B, an *Axinus* and *Pullastra arenicola*.

I could find no continuous sections showing the junction of these beds with the overlying Lias, but about half a mile higher up the stream to the east, the bank, 14 feet high (Fig. 2), presents the following section—A, drift, two or three feet thick; B, limestone bands, three or four inches thick, with obscure casts of fossils; C, dun-coloured sandy shales, eight feet thick; D, bluish-black fissile shales of unknown thickness, occurring in the bed of the brook, and closely resembling B or D in section, Fig. 1, of which it may possibly be the upper portion.

FIG. 2.



Section half a mile SE. of Audlem.

Mr. Etheridge has determined from these beds *Myacites auconoides*, *Modiola minima*, and *Pullastra arenicola*, and suggests that the bed C, containing *Myacites*, is probably Lower Lias. I failed to find *Avicula contorta* in any part of this section.

IV.—ON THE LOWER SILURIAN ROCKS OF GALASHIELS.

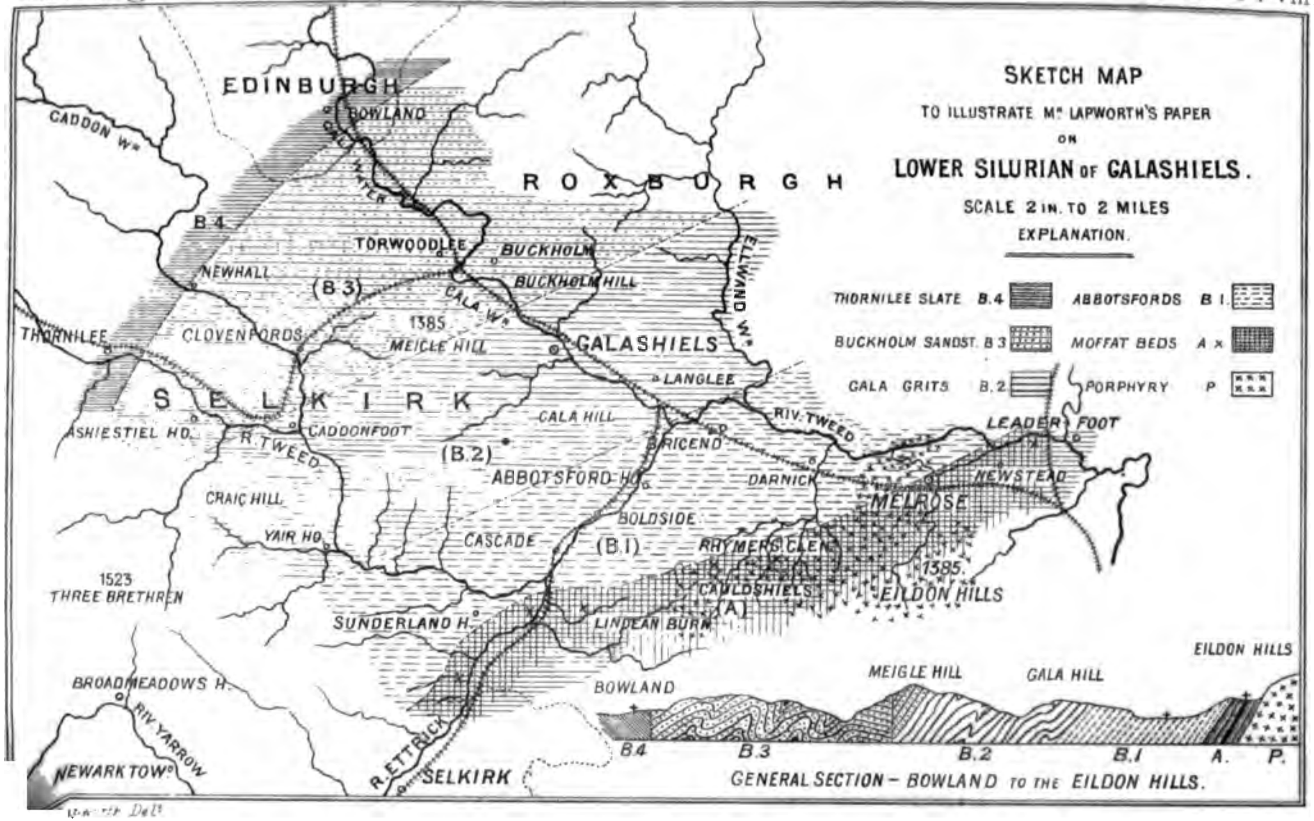
By CHARLES LAPWORTH, Esq.

PART I.

(PLATE VIII.)

THE Lower Silurian rocks of Scotland, largely developed as they are in the south, and in spite of the great labour that has been bestowed upon them, are by far the least known of all the fossiliferous formations of that country. While the maps of the Government Geological Survey are coloured in all the subdivisions of the strata of the other formations included in their area, the Lower Silurians are merely indicated by a common purple tint, and not the slightest attempt at a subdivision is made. Even the single bed of Limestone they contain, below the horizon of that of the W. coast, is doubtfully referred to the Llandeilo, and the sign of interrogation is carefully placed before its title. Nicol, Harkness, J. C. Moore, and many other eminent geologists, have worked different portions of these ancient deposits since the publication of "The Silurian System," but as yet very little progress has really been made in correlating its different parts with those of the type formation of the sister country.

Now, this want of accurate information is due to two causes. 1st—The strata are so rapidly folded and contorted, and are consequently so intricate and confused, while, at the same time, they present so few differences lithologically, that anything like a physical separation of its masses is well nigh impossible; and 2nd—The whole formation, with the exception of a few isolated bands of Limestone towards the west, and some bands of Anthracitic shale that make their appearance about the geographical centre of the system, seems to be nearly destitute of organic remains.



SKETCH MAP
TO ILLUSTRATE Mr. LAPWORTH'S PAPER
ON
LOWER SILURIAN OF GALASHIELS.
SCALE 2 IN. TO 2 MILES

EXPLANATION.

THORNILEE SLATE	B.4	▩	ABBOTSFORDS	B 1.	▤
BUCKHOLM SANDST.	B 3	▦	MOFFAT BEDS	A ×	▩
GALA GRITS	B. 2	▤	PORPHYRY	P	▨

GENERAL SECTION – BOWLAND TO THE EILDON HILLS.

The following has been considered to be the ascending order in the Lower Silurian of the South of Scotland:—

1. The Bottom Rocks of Hawick and Borthwick water.
2. The parti-coloured Shales and Greywackes of Dryfe water.
3. The Moffat Series or Anthracitic Schists.
4. A thick group of Greywackes and Shales, supposed to include the Grieston and Barlae flags.
5. The Wrae Limestone and its superimposed Shales.
6. The Caradoc of Girvan.
7. The Llandovery of Girvan.

Such is the order generally received among geologists, but there is necessarily much difference of opinion, and all below the limestones of Carrick may be said to be in an exceedingly confused and uncertain condition. The Wrae Limestone has been paralleled by some with that of the Stinchar, and considered to be the equivalent of the Bala Limestone of Wales, while the Geological Survey doubtingly places it among the Llandeilo beds. At the same time the Anthracitic Schists of Moffat are proved by their fossil contents to belong to the Upper Llandeilo, and thus no place is left in the system for the 24,000 feet of strata supposed to lie between these well-marked horizons. (Geol. Journal, vol. xi., p. 393.)

Professor Harkness endeavours to rid himself of this awkward difficulty by placing the Moffat beds in the Lower Llandeilo, and considering them of the age of the Skiddaw Slates (Geol. Journal, vol. xi., p. 393), and, when this idea has to be abandoned, by supposing the Grieston and Barlae flags to represent the Fucoidal Sandstones of Sweden, and thus to be inferior to the Moffat series, but repeated to the north by faults or flexures (Geol. Journal, vol. xii., p. 238); while Mr. Geikie is of opinion that "One cannot cross the section of these strata in the railway cuttings, or traverse the valleys between the line of the Wrae Limestone and the Dobb's Linn Anthracitic bands, without surmising that on the whole there is an ascending section to the N.W., and hence, that there must be a group of thick beds of Greywackes and Shales between the Anthracitic series and the Limestone." (Trans. Geol. Soc., Glas., v. iii., p. 81.)

There are three places known to be fossiliferous in this unplaced and puzzling portion of the Lower Silurian—viz., Grieston, near Innerleithen; Thornilee, near Galashiels; and Barlae, near New Galloway.

From the Grieston, Professor Nicol obtained *Graptolithus priodon* (Bronn), *G. convolutus* (His.), *G. distans* and *G. tenuis* (Portlk.), and a new species he named *Griestonensis*. (Geol. Journal, vol. vi., p. 53.)

From Thornilee he obtained *G. priodon*, *G. convolutus*, and another form, which Mr. Salter ultimately pronounced to be a scalariform impression of *G. sagittarius* (His.); also *Crossopodia Scotica* (M'Coy), and *Nereites Cambrensis* (Murch.). (Geol. Journal, vol. xi., p. 53.)

From the Barlae flags Professor Harkness has obtained *Chondrites*, *Crossopodia*, *Trichoides*, *Algæ*, and a small *Olenus*. (Geol. Journal, vol. xi., p. 393.)

If we except *G. priodon*, and allow the Annelides a share in determining the age of the strata, the whole fauna seems to point to a very low place in the system, and Professor Harkness appears quite justified in referring the whole group to a position inferior to that of the Moffat Series.

Now, it is of this especial portion of the Scottish Lower Silurians I have to speak, and I trust I shall be able to show, from its fossil contents, that it is not only superior to the Moffat beds, but that the evidence goes far to show that it is the representative, in time, of part of the Coniston group of England, or in other words, of a portion of the Caradoc formation of the typical Siluria.

THE LOWER SILURIANS OF GALASHIELS.

The town of Galashiels lies about four miles to the south-east of the Thornilee Quarry, mentioned above, and, as nearly as I can ascertain, about the centre of the puzzling group of strata I have more particularly noticed. Until within the last year no fossils had been found in the neighbourhood, south of Thornilee; and it is with their discovery, and the light they throw on the position and age of the strata, I have more especially to deal.

My colleague—Mr. James Wilson, of Galashiels—and myself, assisted by Mr. Wardrop, of Ladhope, have devoted much of our leisure to the careful examination of the rocks of the neighbourhood, during the past summer, and have found them to be abundantly fossiliferous in places, and to contain what seems to be a distinct and characteristic fauna.

The rocks from which fossils have been obtained stretch in a north-westerly direction from the Eildon Hills, through the town of Galashiels, to the Thornilee Quarry; and as the Grieston contains the same fauna, generally speaking, as that of our higher beds, I shall include that classic quarry in my description.

The whole series, which may be called "The Gala Group," is separable into four main divisions, in what seems to be the ascending order, viz.:—

1. The Abbotsford flags and Greywackes,
2. The Gala Grits,
3. The Buckholm Sandstones,
4. The Slates of Thornilee and the Grieston,

the whole underlain by the representative of the higher portion of the Moffat Series, or Anthracitic Schists.

All these beds dip, as a rule, to the N.W. till they reach Thornilee, where they turn over to the S.E., and continue thus to Innerleithen, where the N.W. dip is resumed and is held to the Grieston.

The average dip is about 60°, and the total distance across the strike about three miles, which gives us a gross thickness, in round numbers, of 13,000 feet. Allowing one-third of this for folds, we have a net thickness of about 9,000 feet, to which, if we add 1,000 feet for the slates of Thornilee and the Grieston, we get an approximate thickness of 10,000 feet for the whole of the known Gala Group —or less than one-half that estimated by Professor Harkness (Geol. *Journal, vol. xi.,* p. 393). This is the greatest thickness possible;

the real thickness may be but a fraction of this estimate, but it cannot exceed it.

There are few exposures of the rocks themselves. Quarries for dry-stone dykes, and the rocky beds of rivers, which are submerged for ten months in the year, afford, roughly speaking, the only means of reaching the strata, so that nothing like a section is attempted, and a short description only of the different beds is subjoined; premising that the distinctive lithological characters are drawn principally from the varying appearance of the more shaly strata, and that the order here adopted is necessarily to a certain extent geographical.

(*A*) *Rocks of the Moffat Series.*

First, then, for the underlying band of Anthracite, which I have classed provisionally with the Moffat Series.

The Black Shales make their first appearance in the neighbourhood in a small stream falling into the Ettrick below Sunderland, about a mile and a half above the junction of the Ettrick and Tweed. They are associated with hard-jointed grits, and indurated yellow, bluish, or white shales, and have as yet yielded no fossils.

They are next seen crossing the Ettrick, at Lindean Bridge, are of the usual type, and exceedingly crushed and contorted. They have, however, here yielded *D. pristis* (His.) and a *Cladograpsus.*

Prolonging the line of strike (which is here from 20° to 25° N.E.), we meet with the Black Shales once more in a small burn that runs from near Cauldshiels into the Ettrick, a quarter of a mile below Lindean. They are here developed to a greater extent than at any other place in the district, and have, as usual, been fruitlessly bored for coal. They are excessively disturbed, and are interlaced by fine veinings of quartz; but we have managed to obtain from them *Diplograpsus teretiusculus* (His.), *D. vesiculosus* (Nich.), *D. pristis* (His.), *Cladograpsus capillaris* (Carr), and *Graptolithus sagittarius* (His.). They are not seen again until we reach a small burn that runs down from the hills to the west of Eildon, through a gully called the Rhymer's Glen, but there are traces of their presence at the S.E. end of Cauldshiels Loch, where their associated purple and whitish shales are seen intersected by many dykes of the Eildon porphyry, and from these shales we have procured *Graptolites lobiferus* (M'Coy), *i.e., G. Beckii* (Barr) and *G. Nicoli* (Hark.), two varieties of *G. Nilssoni* (Barr), *G. Sedgwickii* (Portlock), *Rastrites triangulatus* (Hark.), *R. maximus* (Barr), *R. Linnæi* (Barr), in addition to those mentioned as present in the Lindean burn.

At the Rhymer's Glen the dark shales are seen to be interstratified with heavy greywackes, and the purple and blue shales are well exposed, but seem to be unfossiliferous. The black beds have yielded *Siphonotreta micula* (M'Coy), together with a few fragments of *Graptolithus.*

After passing beneath the south slope of Eildon, and crossing the railway near Newstead, where their course can be made out with difficulty, they are seen for the last time, before they plunge beneath the Old Red Sandstone of Berwickshire, in the north bank of Tweed, about 200 yards above the railway viaduct at Leaderfoot, and are charged with *Diplograpsus pristis.*

The relation of this band of black shale to the associated strata in this district is very obscure; but, as we have never been able to detect it either to the north or south of this line, it may be surmised that there is no great dislocation of the strata, and no fold of sufficient intensity to bring the band again to the surface.

Every fossil yet found in these beds belongs to the fauna of Moffat, and there is very little doubt that this line of black shale is the continuation of that which is so persistent in that district; or, if there be more than one band, this must be the higher, or that of Dobbs' Linn and Frenchland Burn, which seems characterised by the comparative rarity of *Didymograpsus* and other peculiar Llandeilo forms.

(B) *The Gala Group.*

(1.) *The Abbotsford Flags and Greywackes.*—These lie to the north of the line of Anthracitic Shale that marks the approach to the summit of the Moffat beds, from which I imagine they are separated by some thick band of hard conglomeratic grit, which contains small fragments of the Black Shales here and there in abundance.

These peculiar grits seem to be pretty persistent, for I have met with them in the neighbourhood of St. Mary's Loch, thirty miles distant along the strike, and apparently holding the same position with reference to the Black Shales. We have, however, never met with these beds *in situ* in this district, though I have found angular fragments of the peculiar stone strewn over the fields to the north of Cauldshiels. These marked beds seem to point to a want of conformity between the Gala and Moffat beds—locally, at least, if not throughout the whole extent of the Lower Silurian of the south of Scotland.

Above this grit, as far as can yet be ascertained, come rapid alternations of flaggy schists, with shaly partings, often bluish or dark grey in colour, and containing here and there seams of slightly carbonaceous shale, often tinged with oxide of iron; sometimes finely levigated and apparently unfossiliferous, sometimes of a more arenaceous character and containing fossils.

These flaggy beds, of which there is no workable exposure in the Gala country, have yielded in the Yarrow, above Selkirk, *Graptolithus priodon* (Bronn), *G. Sedgwickii* (Port.), *G. lobiferus* (M'Coy), *G. Nilsoni* (Barr), *Rastrites triangulatus* (Hark.), *R. Linnæi* (Barr), and *Dip. teretiusculus* (His.).

Graptolithus priodon distinguishes the beds at once from those of Moffat, and proves conclusively that we are now in a superior set of strata.

These flaggy and schistoze beds are succeeded on the north by more solid-bedded greywackes, full of innumerable joints, and often separated by beds of slightly arenaceous shale. The surfaces of the joints are often coated with indigo-coloured matter, while the shales weather in nearly all cases to a pale yellow tinge. These beds are exposed along the Tweed, from the junction of that river with the Ettrick, almost to the town of Melrose, wherever the bank or bed of the river is rocky.

The fossils here present a more decided Coniston facies, and include *G. Sedgwickii—spinigerus* (Nich.), *proteus* (Barr), and *triangulatus* (Hark.)—*G. lobiferus* (M'Coy), *G. exiguus* (Nich.), *G. Nilssoni*, *G. priodon* (Bronn), *G. colonus* (Barr), *G. turriculatus* (Barr), and *Retiolites Geinitzianus* (Barr), together with *Dictyonema*, *Peltocaris aptychoides* (Salt.), *Ceratiocaris sp.*, *Orthoceras*, and many indeterminate fossils, among which are fragments of a couple of varieties of Corals, a reticulated fossil—perhaps *Stromatopora striatella* (Lonsdale)—and what Dr. Page considers to be the jaw-foot of some species of *Pterygotus*.

(2.) *The Gala Grits.*—Overlying the Abbotsford beds, and divided from them by a persistent sett of laminated or tiley beds (the Bridgend Flags), and also surmounted by another band of nearly the same nature (the Ellwand Slate), come the Gala Grits. They consist generally of heavy greywackes, with shaly partings, and contain occasionally seams or beds of foliated shale of varying colours, generally yellow or reddish, but sometimes of a cold green colour. The thinner seams are finer in texture, often grey and crumbly, sometimes blue or dark green, and hard and splintery. The grits of the lower beds are fine-grained, homogeneous, green, and thin-bedded; those of the upper portions are heavier, of a fine blue colour, and very quartzose.

Fossils are comparatively rare, and where found are those of the Abbotsford Greywackes.

(*To be concluded in the June Number.*)

V.—THE BOULDER-CLAY OF CAITHNESS A PRODUCT OF LAND-ICE.

By JAMES CROLL, of the Geological Survey of Scotland.

PART I.[1]

The Nature of the Caithness Boulder-clay.

A CONSIDERABLE amount of difficulty has been felt by geologists in accounting for the origin of the Boulder-clay of Caithness. It is an unstratified clay, of a deep grey or slaty colour, resembling much that of the Caithness flags on which it rests. It is thus described by Mr. Jamieson (Quart. Jour. Geol. Soc., vol. xxii. p. 261):

"The glacial drift of Caithness is particularly interesting as an example of a Boulder-clay, which in its mode of accumulation and ice-scratched débris very much resembles that unstratified stony mud which occurs underneath glaciers—the '*moraine profonde*,' as some call it.

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[1] This paper is illustrated by a Map (PLATE X.), which will appear, together with the concluding part of the article, in our June Number.—EDIT.

"The appearance of the drift along the Haster Burn, and in many other places in Caithness, is in fact precisely the same as that of the old Boulder-clay of the rest of Scotland, except that it is charged with remains of sea shells and other marine organisms.

"If want of stratification, hardness of texture, and abundance of well-glaciated stones and boulders are to be the tests for what we call genuine Boulder-clay, then much of the Caithness Drift will stand the ordeal."

So far, therefore, as the mere appearance of the drift is concerned, it would be at once pronounced to be true Lower Till, the product of land-ice. But there are two circumstances connected with it which have been generally regarded as fatal to this conclusion.

(1) The striæ on the rocks show that the ice which formed the clay must have come from the sea, and not from the interior of the country; for their direction is almost at right angles to what it would have been had the ice come from the interior. Over the whole district, the direction of the grooves and scratches on the rocks is pretty nearly N.W. and S.E. But this is not all, the very stones in the clay are striated in this direction. "When examining the sections along the Haster Burn," says Mr. Jamieson, "in company with Mr. Joseph Anderson, I remarked that the striæ on the imbedded fragments generally agreed in direction with those of the rocks beneath. The scratches on the boulders, as usual, run lengthways along the stones when they are of an elongated form; and the position of these stones, as they lie embedded in the drift is, as a rule, such that their longer axes point in the same direction as do the scratches on the solid rock beneath; showing that the same agency that scored the rocks also ground and pushed along the drift."

Mr. Peach informs me that he seldom or never found a stone with two sets of striæ on it, a fact indicating, as Mr. Jamieson remarks, that the drift was produced by one great movement invariably in the same direction. Let it be borne in mind that the ice, which thus moved over Caithness in this invariable track, must either have come from the Atlantic to the N.W., or from the Moray Firth to the S.E.

(2) The Boulder-clay of Caithness is full of sea-shells and other marine remains. The shells are in a broken condition, and are interspersed like the stones through the entire mass of the clay. Mr. Jamieson states that he nowhere observed any instance of shells being found in an undisturbed condition, "nor could I hear," he says, "of any such having been found; there seems to be no such thing as a bed of laminated silt with shells *in situ*." The shell-fragments are scratched and ice-worn, the same as the stones found in the clay. Not only are the shells glaciated, but even the Foraminifera, when seen through the microscope, have a rubbed and worn appearance. The shells have evidently been broken, striated, and pushed along by the ice at the time the Boulder-clay was being formed.

Theories Regarding the Origin of the Caithness-clay.

Mr. Jamieson, as we have seen, freely admits that the Boulder-clay of Caithness has the appearance of true land-ice Till, but from the N.W. and S.E. direction of the striæ on the rocks, and the presence of sea-shells in the clay, he has come to the conclusion that the glaciation of Caithness has been effected by floating ice at a time when the district was submerged. I have always felt convinced that Mr. Jamieson had not hit upon the true explanation of the phenomena.

(1) It is physically impossible that any deposit formed by icebergs could be wholly unstratified. Suppose a mass of the materials which would form Boulder-clay is dropped into the sea from, say an iceberg, the heavier parts, such as stones, will reach the bottom first. Then will follow lighter materials, such as sand, then clay, and last of all the mud will settle down over the whole in fine layers. The different masses dropped from the various icebergs, will, no doubt, lie in confusion one over the other; but each separate mass will show signs of stratification. A good deal of Boulder-clay evidently has been formed in the sea, but if the clay be unstratified, it must have been formed under glaciers moving along the sea bottom as on dry ground. Whether *unstratified* Boulder-clay may happen to be formed under water or on dry land, it must in either case be the product of land-ice (see Philosophical Magazine for November, 1868, p. 374). Those who imagine that materials, differing in specific gravity like those which compose Boulder-clay, dropped into water, can settle down without assuming the stratified form, should make the experiment, and they would soon satisfy themselves that the thing is physically impossible. The notion that unstratified Boulder-clay could be formed by deposits from floating ice, is not only erroneous, but is also positively pernicious, for it tends to lead those who entertain it astray in regard to the whole question of the origin of drift.

(2) It is also physically impossible that ice-markings, such as those everywhere found on the rocky face of the district, and on the imbedded pebbles and shells found in the clay, could have been effected by any other agency than that of land-ice. I need not here enter into any discussion on this point. This has been done at considerable length on a former occasion—(see Philosophical Magazine for November, 1868, pp. 366–374). A discussion on this point is, however, unnecessary in the present case, because, if it can be shown that all the facts can be accounted for in the most natural manner by the theory of land-ice, no one will seek to contend for the floating-ice theory; for it is admitted that, with the exception of the direction of the striæ and the presence of the shells, all the other facts agree better with the land-ice than with the floating-ice theory.

My first impression on the subject was that the glaciation of Caithness had been effected by the polar ice-cap, which, during the severer part of the glacial epoch, must have extended down to at least the latitude of the north of Scotland.

On a former occasion, see the "Reader" for 14th October, 1865, it was shown that, owing to the shallowness of the northern seas, those seas must have been at that period all blocked up with solid ice, displacing the water and moving along the sea bottoms, the same as on dry land elevated above the sea level. In fact the northern seas, including the German Ocean, being filled at the time with glacier-ice, might be regarded as dry land. Ice of this sort, moving along the bed of the German Ocean or North Sea, and over Caithness, could not fail to push before it the shells and other animal remains lying on the sea bottom, and to mix them up with the clay which now remains upon the land as the evidence of its progress.

About two years ago I had a conversation with Mr. Peach on the subject. This gentleman, as is well known, has long been familiar with the Boulder-clay of Caithness. He felt convinced that the clay of that country is the true lower till, and not a more recent deposit, as Mr. Jamieson supposes. He expressed to me his opinion that the glaciation of Caithness had been effected by masses of land-ice crossing the Moray Firth from the mountain ranges to the South-east, and passing over Caithness in its course. The difficulty which seems to beset this theory is, that a glacier entering the Firth would not leave it and ascend over upon Caithness. It would take the path of least resistance and move into the North Sea, where it would find a free passage into deeper water. Mr. Peach's theory is however an important step in the right direction. It is a part of the truth, but I believe not the whole truth. The following is submitted as a solution of the question.

The Proposed Theory.

The opinion is now pretty well established that, during the severer part of the Glacial period, Scotland was covered with one continuous mantle of ice, of such a thickness as to bury under it the Ochils, Sidlaw, Pentlands, Campsie, and other moderately high mountain ranges. For example, Mr. Geikie and some of the other officers of the Geological Survey found that the great masses of the ice from the North-west Highlands, came straight over the Ochils of Perthshire and the Lomonds of Fife. In fact, these mountain ridges were not sufficiently high to deflect the icy stream either to the right hand or to the left. The flattened and rounded tops of the Campsie, Pentland, and Lammermoor ranges, bear testimony to the denuding power of ice. And I have been informed that a member of the Edinburgh Geological Society has lately found Boulder-clay on the Pentlands at an elevation of 1,600 feet.

The following facts, recorded by Mr. Jamieson, will show how prodigious must have been the thickness of the ice in the North Highlands.

"All the facts," says Mr. Jamieson, "are in harmony with the notion that the ice was of enormous thickness. Thus the detached mountain of Schehallion in Perthshire, 3,500 feet high, is marked near the top as well as on its flanks, and this not by ice flowing down the sides of the hill itself, but by ice pressing over it from the north.

On the top of another isolated hill, called Morven, about 3,000 feet high, and situated a few miles to the north of the village of Ballater, in the county of Aberdeen, I found granite boulders unlike the rock of the hill, and apparently derived from the mountains to the west. Again, on the highest water-sheds of the Ochils, at altitudes of about 2,000 feet, I found this summer (1864), pieces of mica schist full of garnets, which seem to have come from the Grampian Hills to the north-west, showing that the transporting agent had overflowed even the highest parts of the Ochil ridge. And on the West Lomonds, in Fifeshire, at Clattering-well Quarry, 1,450 feet high, I found ice-worn pebbles of Red Sandstone and porphyry in the debris, covering the Carboniferous Limestone of the top of the Bishop Hill. Facts like these meet us everywhere. Thus on the Perthshire Hills, between Blair Athol and Dunkeld, I found ice-worn surfaces of rocks on the tops of hills, at elevations of 2,200 feet, as if caused by ice pressing over them from the north-west, and transporting boulders at even greater heights." Journ. Geol. Soc., vol. xxi., p. 165.

It is therefore evident that the great mass of ice entering the North Sea to the East of Scotland, especially about the Firths of Forth and Tay, could not have been less than from 1,000 to 2,000 feet in thickness. Its thickness, however, was probably much greater than that.

The grand question now to be considered is, what became of the huge sheet of ice after it entered the North Sea? Did it then break up, and float away as icebergs? This, hitherto, appears to have been taken for granted. The average depth of the North Sea is not over 40 fathoms. It is therefore perfectly obvious that a glacier 1,000 or 2,000 feet in thickness could not possibly have floated in such a sea. This depth of water is not sufficient to float a glacier 300 feet thick. The ice must consequently have moved along on the bed of the sea in one unbroken mass, the same as it would have done had its bed been dry land. The North Sea gradually deepens, from about 20 fathoms at the English Channel to about 50 fathoms at the north of Scotland. The 50-fathom line crosses from about the Moray Firth over to near the coast of Norway, and we must go to the north and west of the Orkney and Shetland Islands before we reach the 100-fathom line. The ice-sheet of Scotland could not, therefore, have broken up into icebergs in the North Sea. While it remained in this region it would be land-ice. The sheet must have found its way to the deep trough of the Atlantic, to the west of the Orkney and Shetland Islands, before it could possibly have floated away in the form of icebergs.

No doubt the North Sea, for two reasons, is now much shallower than it was during the period in question. (1.) There would, at the time of the great extension of the ice on the northern hemisphere, be a considerable submergence, resulting from the displacement of the earth's centre of gravity (Phil. Mag. for April, 1866). (2.) The North Sea is now probably filled up to a larger extent with drift deposits than it was at the ice period. But, after making the most extravagant allowance for the additional depth gained on this account, still there could not possibly be water sufficiently deep to float a glacier of one or two thousand feet in thickness. The North Sea would have required to be nearly ten times deeper than it is at present to have floated the ice of the Glacial period. The mass under which, as we have seen, the Ochils were then buried, if placed in the centre of that sea, would still have its upper surface as high above the sea level as the tops of our Pentlands. We may conclude, with the most perfect certainty, that the ice entering the North Sea from the east of Scotland must have continued its course in one unbroken mass till it reached the deep water of the Atlantic, to the west of the Orkney and Shetland Islands. It is hardly necessary to remark that the waters of the North Sea would have but little effect in melting the ice. A shallow sea like this, into which large masses of ice were entering, would be kept constantly about the freezing point, and ice-cold water has but little melting power. It takes 142lbs. of water, at 33° of temperature, to melt one pound of ice. In fact, an icy sea tends rather to protect the ice entering it from being melted than otherwise. And besides, owing to fresh acquisitions of snow, the ice-sheet would be accumulating more rapidly upon its upper surface than it would be melting at its lower surface, supposing there were sea-water under that surface. The ice of Scotland during the glacial period must, of necessity, have found its way into warmer water than that of the North Sea before it could have been melted. But this it could not do without reaching the Atlantic, and in getting there it would have to pass round by the Orkney Islands, along the bed of the North Sea, as land-ice.

This will explain how the Orkney Islands may have been glaciated by land-ice; but it does not, however, explain how Caithness should have been glaciated by that means. These islands lay in the very track of the ice on its way to the Atlantic, and could hardly escape being overridden; but Caithness lay considerably to the left of the path which we would expect the ice to have taken. The ice would not leave its channel, turn to the left, and ascend over upon Caithness unless it were forced to do so. What, then, compelled the ice to pass over Caithness?

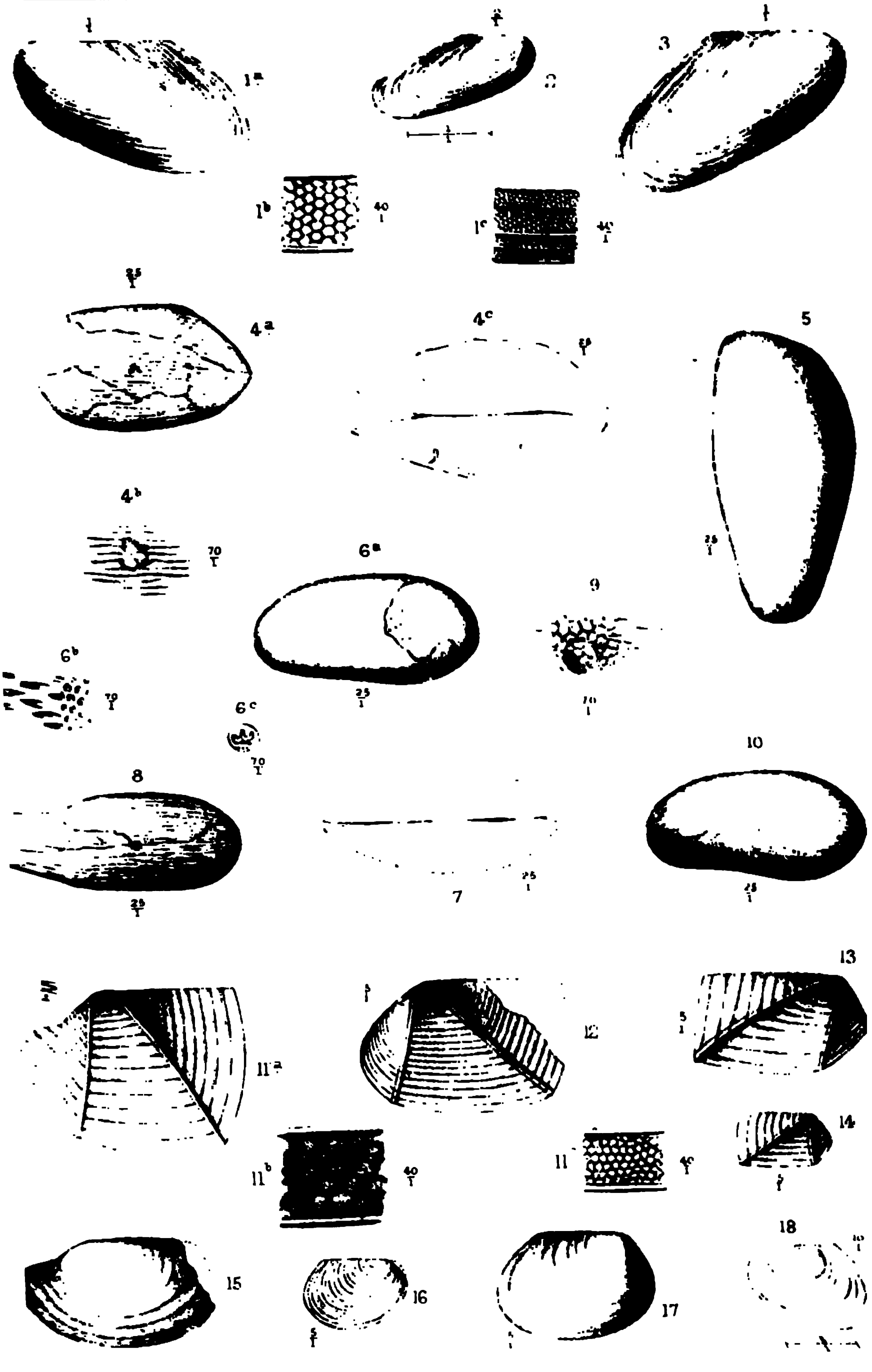
(*To be concluded in the June Number.*)

VI.—On some Bivalved Entomostraca from the Coal-measures of South Wales.

By Prof. T. Rupert Jones, F.G.S.

(PLATE IX.)

In the spring of 1869 Mr. William Adams, F.G.S., of Cardiff, sent to me for examination several pieces of Coal-shale, bearing some minute organisms which had been recognized as Entomostraca by Mr. Charles Moore, F.G.S. The shale, in some of its layers, which are more or less bituminous, is full of *Anthracomya Phillipsii*, eol. Mag. 1870 Vol VII Pl



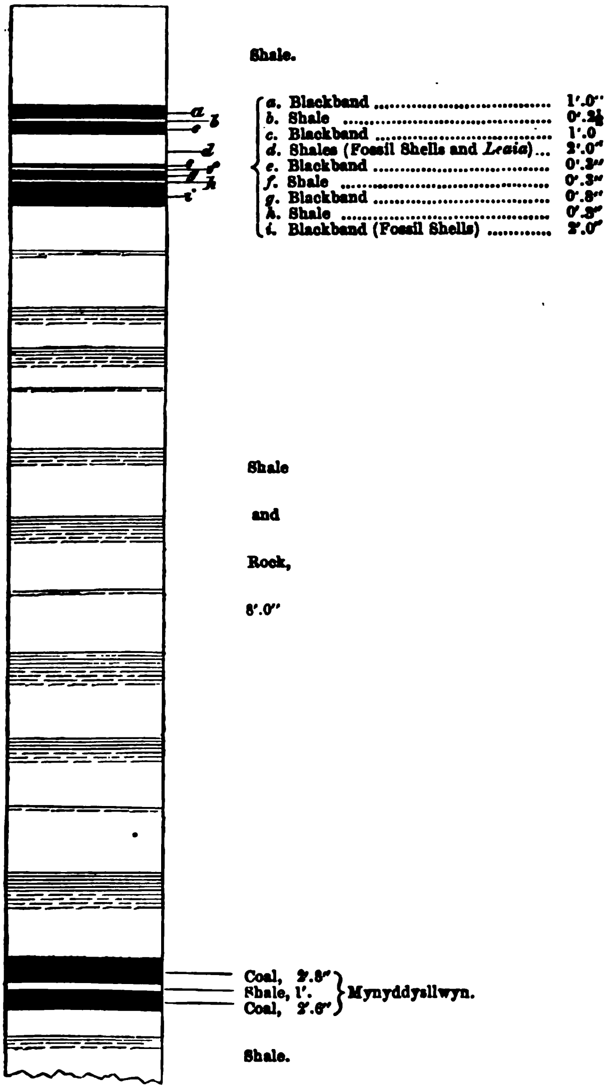
Carboniferous Entomostraca, &c.

Williamson, sp.; and amongst these shells are a few others, differing very slightly in shape, but characterized by their minutely reticulate surface, therein resembling *Estheria*. There are also a few specimens of *Estheria tenella*, and numerous small Cytheroid forms, which cannot belong to either *Cythere* or the allied genera, as far as the carapaces show. In some pieces of the bituminous shale another Entomostracan Bivalve, namely, *Leaia*, occurs in abundance on some slabs, but without associates. This genus is now for the first time found so far south in Britain; the hitherto known specimens have come from different parts of North America (Pennsylvania, Illinois, and Nova Scotia), from Scotland, Lancashire, and Germany. A layer of what at first sight appear to be small Seeds or Spore-cases coats one face of a slab rich with *Anthracomya* and *Estheria*, but these little bodies are possibly small Daphnia-like Entomostraca, as suggested by Mr. Carruthers, F.G.S. A single larger Spore-case (?) occurs on another piece, and a Lepidodendroid leaf on another. In some of these shales there occur black shining circular spots, with irregularly concentric wrinkles, that at first sight look like compressed fruits; but Mr. Carruthers has explained (Brit. Assoc. Meeting, 1869) their nature and origin, as spots where gases, disengaged from decomposing organic matter, formed bubbles, imprisoned in the mud; and, whilst gradually diminishing, their successive walls were again and again squeezed and slickensided by the double action of pressure and expansion. The less bituminous shale contains fragments of *Neuropteris* and *Cyclopteris* (?). Fish (?) bones also occur on some of the slabs.

These shales, associated with "Black Band Ironstone" of the South-Welsh Coal-field, are regarded by Mr. Adams as the equivalent of the bed referred to as "Rider [Coal], 1 foot," in the Section of strata of the "Pennant" series, at page 172 of the Mem. Geol. Survey, Iron-ores, Part iii., 1861. Mr. Adams informs me that "about one and a half mile south-west of Bedwelly Church, and one and a quarter mile north-east of Gelligaer Church (on Sheet 36 of the Ordnance Survey Map), in Glamorganshire, on the west side of the River Rumney, a coal-level was opened on the crop of the Mynyddysllwyn Coal, on Cilfach-bargoed-fawr Farm. After driving westward in the coal, they struck a down-throw west fault (from 25 to 30 yards); and in place of the coal, or rather on the same level, came in the Black Band beds, and in these the fossil shells are found. (See Section.) The Black Band is apparently of limited area. This new bed of fossil shells is about 800 ft. higher in the South-Welsh Coal-measures than any hitherto met with. At Llancariach Colliery, the property of George Worthington, Esq., 1¼ miles nearly due west from Gelligaer Church, this Black Band again occurs, with the same fossil shells, some acres in extent, but of less thickness than at the works above mentioned; and here also it is between two faults."

A shale full of *Anthracomyæ* of the same species as that above noticed has also been found by Mr. Adams at Aberbeeg, in the Ebbw Valley, overlying a coal called the Troed-rhiw-Clawdd Coal, which lies at the bottom of the Pennant rocks, about 226 yards below the Mynyddysllwyn Coal.

SECTION OF STRATA AT CILFACH BARGOED COLLIERY.


Shale.
a
b
c
d
e
f
g
h
i
a. Blackband .... 1'.0"
b. Shale .... 0'.2½
c. Blackband .... 1'.0
d. Shales (Fossil Shells and *Leaia*)... 2'.0"
e. Blackband .... 0'.3"
f. Shale .... 0'.3"
g. Blackband .... 0'.8"
h. Shale .... 0'.3"
i. Blackband (Fossil Shells) .... 2'.0"
Shale
and
Rock,
8'.0"
Coal, 2'.8"
Shale, 1'.
Coal, 2'.6"
Mynyddysllwyn.
Shale.

(Scale 20 feet to the inch.)

§ 1. *Anthracomya.*—The Molluscan shells referred to above are very numerous, flattened and compressed, in layers. The chief form is similar to Prof. Williamson's *Unio Phillipsii*, from the Upper Coal-measures at Ardwick, near Manchester, described by him in the "Phil. Mag.," 1836, p. 241. It is the same also as Prof. Phillips's *Unio linguiformis*, "Sil. Syst.", p. 88, and Mr. Binney's *Modiola* (?), "Manchester Lit. Phil. Soc. Trans.", vol. xii. p. 221. Prof. Williamson has lately favoured me with a sketch of this shell, and with a piece of the Ardwick shale. The same form occurs plentifully in the Coal-shales of other places, and has been labelled *Anthracomya* (*Unio*) *Phillipsii* in the Museum of the Geological Survey. In 1861 Mr. Salter instituted the genus *Anthracomya* for such shells as these, of which there are several forms that "have oscillated between *Avicula* and *Modiola*, and even *Unio*" ("Iron-ores," etc., p. 230). Prof. King's *Anthracosia* had already taken in the Unio-like forms, and Mr. Salter afterwards proposed *Anthracoptera*[1] for the reception of the obliquely angular forms, somewhat like *Myalina* and *Dreissena*.

Fig. 1, Pl. IX., represents the *Anthracomya*, so abundant in the shales under notice; specimens like Fig. 18 are rare. The shell is concentrically wrinkled, somewhat irregularly, and the ridges are modified by pressure. The surface is marked with fine lines parallel to the ridges. Fig. 3, in plate 2 of the "Iron-ores, etc.," Part iii., may be a small *Anthracomya Phillipsii*, but it is rather too narrow.

§ 2. *Estheria Adamsii.*—Together with the above we find several very similar shells, concentrically ridged, but marked all over with microscopic pittings, like the pattern of a thimble-top on a very minute scale—an ornament very unusual in Molluscs, but common in *Estheria* (*E. Dunkeri* and *E. Hislopi*, Baird, for instance). The punctation differs from that of the little Mollusc, *Lepton squamosum*, in being far smaller and very much more closely set. The best preserved specimen of this Estheria-like shell is more like *Anthracomya Adamsii* (Salter, "Iron-ores, etc.," Part iii., p. 230, pl. 2, fig. 7) in shape than *A. Phillipsii*, being less oblique than the latter, and having a longer hinge-line. The specimens, however, are all too much crushed to be taken as perfect types of form.

In some slabs of shale there are films of whitish minute network, which appear to have resulted from the decomposition of these punctate shells; whilst the common *Anthracomyæ* have become changed, sometimes into white calcareous shells, but are usually brownish, sometimes minutely granular, but not reticulate.

The outline of the reticulate valves, when perfect, or nearly so (Fig. 1), closely approaches that of *Estheria striata*, var. *Beinertiana* (Monog. Foss. Esth., p. 25, pl. 1, fig. 13). The superficial ornament, however, constitutes a specific difference. In other cases the valve is narrower, and has a shorter hinge-line (Fig. 2); but it is difficult to determine if this be an original shape, or if it be due to squeezing.

I propose to register this large *Estheria* (more than an inch in length), obliquely ovate in outline, with a long straight hinge, and with numerous concentric irregular ridges, and a general ornament of very minute hexagonal punctation, as *E. Adamsii.* In ornament it resembles *E. punctatella*, Jones, as well as the recent forms mentioned above, but differs from them materially in shape.

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[1] Quart. Journ. Geol. Soc., 1863, vol. xix., p. 80.

In the piece of Anthracomyan shale from Ardwick, given me by Prof. W. C. Williamson (see above, p. 217), I also recognize, under the microscope, a morsel of a similar reticulate valve. This *Estheria* will therefore be found elsewhere.

In a piece of the shale from Mr. Adams's collection, I observe two specimens of *Estheria tenella* (Monog. Foss. Esth., p. 31, pl. 1, fig. 26, 27, &c.).

§ 3. *Cytheroid Entomostraca.*—There are at least three Cytheroid forms in the shales under notice; although often crushed, or occurring as mere casts, yet in some instances the valves are well preserved. They differ from known *Cytheræ*, *Cyprides*, &c., not only in the patterns of the "muscle-spot," but in having the inner face of that spot excavated at its margin, and in having the inner surface of the valves reticulated with vascular impressions, especially near the centre. In such points these old Cytheroids have Leperditian and Beyrichian characters; but their valves resemble those of *Cythere* and other *Ostracoda*. The very common Carboniferous species, *Cythere* (?) *fabulina*, Jones and Kirkby, MS. (Trans. Glasgow Geol. Soc., vol. ii., p. 217, 1867), is an allied form, and probably belongs to the same generic group, which I designate *Carbonia.*

1. *Carbonia Evelinæ*, nov. (Pl. IX., Fig. 4).—Subovate; dorsal line divided in unequal thirds by the front and back slopes and the straight hinge-line between. Anterior end sharper than the posterior. Ventral border well curved. Surface wrinkled by numerous small, smooth, rounded ridges, longitudinal, interrupted, sinuous, tapering away amongst themselves, and converging towards the ends of the valves. In the centre of each valve a small circular area or "muscle-spot" is visible, consisting of three or four minute subtranslucent spots crowded together within a darkish circle. The wrinkling of the general surface is continued faintly over these muscle-spots. This species is rare.

2. *Carbonia Agnes*, nov. (Pl. IX., Figs. 6 and 7).—Ovate-oblong; dorsal edge gently arched, ventral line straight or slightly incurved; anterior third of the valve rather larger than the posterior. The surface is quite smooth in some specimens, and shows a small central muscle-spot, consisting of a narrow darkish circle, enclosing a light (translucent) area, in which a dark, irregular, four-bodied spot is set, with a few black specks along one of its edges.

The casts have a faintly reticulated surface, due to the structure of the shell; and on the casts the place of the "muscle-spot" is indicated by a small round area with a raised ledge, higher on one side than the other. There is also a slight transverse hollow behind and below the central spot on the cast.

a. Var. *subrugulosa* (Fig. 10).—Here the shell has its smoothness partially interfered with by faint longitudinal striæ.

β. Var. *rugulosa* (Figs. 8 and 9).—The shell is strongly striated by longitudinal interrupted wrinkles, converging towards the ends of the valves.

The casts also show some faint signs of the wrinkles, together with reticulation around the raised circle of their "muscle-spots." On the outside shell the "muscle-spot" appears only as a small obscure patch of darkish tint.

§ 4. *Carbonia* (?), sp. (Pl. IX., Fig. 5).—There are at least two specimens of a large Cytheroid species, not well preserved, casts only remaining, which deserve notice. The larger one, which is best preserved, is here figured; but it is hazardous to fix its generic relationship. The cast is faintly reticulate.

§ 5. *Leaia Leidyi*, Jones, Monograph of the Fossil *Estheriæ*, 1862, Appendix, p. 115, &c. (Pl. IX., Figs. 11-14). Messrs. Meek and Worthen have shown that in some specimens of *Leaia* (*L. tricarinata*, M. and W., Report Geol. Survey Illinois, 1869, p. 540, &c.) there is evidently a third (dorsal) carina on each valve, bounding a dorsal depression (their "lanceolate false area"), along the bottom of which is the hinge-line. In compressed specimens this is not distinguishable, and whether or no it is present in all (as it well may be) they leave an open question (p. 543). We may add that, thanks to our artist, Mr. George West, we can now point out that *Leaia* had the usual Crustacean ornament of reticulation, so common in Entomostraca, especially in *Estheria*. As this character may have been present in other *Leaiæ*, but destroyed by pressure and change, we cannot use it as a specific character in this case; and as to outline and proportions, the many individuals on the shales found by Mr. W. Adams, in South Wales, comprise all the forms yet figured by Lea, Dawson ("Acadian Geol.," 1868, p. 256), Meek and Worthen, and myself, and may be due to differences in age or sex, or conditions of preservation. Perhaps we may say the same of Geinitz's *L. Bæntschiana*, from the Lower Permian beds near Neunkirchen, "N. Jahrb.," 1864, p. 657. It is, of course, probable that different "species" did exist, and are represented among the several forms found in distant countries; but we still wait for further and decided evidences of specific characterization.

§ 6. *Daphnioid* (?) *Entomostraca.*—On one of the slabs of bituminous shale from South Wales is a layer of small black bodies, acute-ovate and wrinkled, that were at first thought to be spore-cases, but Mr. Carruthers cannot discern any plant character in them, and suggests that they may be small thin Entomostracan valves, analogous to those of the modern *Daphnia* and their allies. They show indications of being bivalved, and have one end more pointed than the other. They are also boldly marked with longitudinal and inosculating wrinkles (probably lines of breakage from compression), which distantly imitate the wrinkles on a collapsed seed-vessel, or even the ornament on some seeds; but the eminent Botanist just mentioned cannot find in them sufficient evidence for a place among vegetable organisms. Mr. Carruthers has reminded me that the woodcuts (figs. 10 and 11) at pages 39 and 40 of Emmons's "American Geology," Part vi., 1859, closely resemble these crushed organisms, and are there referred to Entomostraca.

Appendix.—1. We are enabled, thanks to Principal Dawson, to offer a good drawing (Pl. IX., Fig. 15) of a specimen of the Nova-Scotian *Estheria*, roughly figured in a woodcut at p. 256 of "Acadian Geology," 1868. Not being well preserved, this specimen shows no reticulate or other ornament besides the concentric ridges. These are bold and distant, as in *E. Portlocki*, *E. Mangaliensis*, &c.; but as the form before us differs in outline from the broad-ridged species, we may regard it as distinct, and catalogue it as *E. Dawsoni*. It occurs in the Lower Carboniferous rocks at Horton.

2. Another species of *Estheria* has lately come into my hands, through the kindness of Mr. C. Peach. Several specimens have been found in argillaceous concretions in the Carboniferous Shales of the Camstone quarry, at Salisbury Craigs, Edinburgh, by Mr. B. N. Peach. It is a subquadrate form, boldly ridged. Its sculpture is not preserved, and, indeed, only mere films of the shell itself. The form, however, is sufficiently distinct to authorize us to regard it as a new species—*E. Peachii*.

EXPLANATION OF PLATE IX.

Fig. 1. *Estheria Adamsii*, sp. nov. *a*, Left valve shown; natural size. *b* and *c*. Ornament (*c*, near the margin); magnified 40 diameters.
2. *Estheria Adamsii*, (?). Right valve shown; 2 diam.
3. *Anthracomya Phillipsii*, Williamson, sp. Nat. size.
4. *Carbonia Evelinæ*, sp. nov. *a*, Left valve shown; magn. 25 diam. *b*, Muscle-spot; 70 diam. *c*, Dorsal view of the two valves; 25 diam.
5. *Carbonia ?* sp. A cast; 25 diam.
6 & 7. *Carbonia Agnes*, sp. nov. 6*a*, Left valve shown; 25 diam. 6*b*, Reticulation on the cast, and 6*c*, the muscle-spot; 70 diam. Fig. 7. Dorsal edge of the left valve, and outline of the other; 25 diam.
8 & 9. *Carbonia Agnes*, var. *rugulosa*, nov. 8. Left valve shown; 25 diam., 9. Muscle-spot and reticulation of the cast; 70 diam.
10. *Carbonia Agnes*, var. *subrugulosa*, nov. Left valve shown; 25 diam.
11–14. *Leaia Leidyi*, Jones. Various forms: differences due to age, sex, or variety, probably the first. Fig. 11*a*, Left valve, old; 5 diam. 11*b* and *c*, Ornament (*c*, near the margin); 40 diam. Fig. 12, Left valve, adult (typical form); 5 diam. Figs. 13 and 14, Young right valves; 5 diam.
15. *Estheria Dawsoni*, sp. nov. Left valve (cast); 5 diam.
16. *Estheria tenella*, Jones. Right valve; 5 diam.
17. *Estheria Peachii*, sp. nov. Right valve; 5 diam.
18. *Anthracomya* (young of *A. Phillipsii ?* See fig. 3.). Magn. 10 diam.

VII.—On the Use of the Term *Neocomian*.

By John W. Judd, F.G.S., of the Geological Survey of England and Wales.

THE confusion which has of late years resulted from the multiplication of names for the same geological stratum, formation, or system, sufficiently indicates the necessity for the adoption of certain rules by which our geological nomenclature may be reformed and brought into a state of something like uniformity. When this necessity is acknowledged, but little doubt can arise as to the principles on which such rules must be based; the law of *priority*, with certain necessary limitations and exceptions, will be made to govern the terminology of Geology, as it already does that of almost every other Natural Science. The nature and mode of application such rules of nomenclature have been very fully discussed and fined in the Report of a Committee of the British Association, and several papers by the late Hugh E. Strickland.

In deciding upon a date, which may serve as a limit in such trospective revision as may be called for, geologists will experience tle difficulty. William Smith is the Linnæus of Stratigraphical eology, and the year 1815, the date of the publication of the "Map the Strata of England and Wales," may be safely considered as e era of the foundation of our system of geological nomenclature. ll earlier names, with possibly one or two exceptions, may, like e Biological terms of Ray or Morton, be safely neglected, and the ral claims of all post-Smithian names will then have to be decided cording to the date of their first proposal. This rule will of urse have to be relaxed when it can be shown that the earlier rm is founded on a mistake, involves a palpable absurdity, or leads gross misconception. All projects, like that of D'Orbigny, for volutionizing the terminology of the science, in an attempt at an possible symmetry, may be safely disregarded; especially when ey are based on principles so arbitrary, and methods so Procrustean, those of the French palæontologist, and lead to results so anomaus as making divisions like the *Turonien* and *Callovien*, equilent to such as the *Carboniférien* or *Silurien*. Such terms as Lias," "Cornbrash," and "Gault," if they have not the same lvantages of euphony as the later names "Silurian," "Neomian," and "Miocene," have even stronger claims from prescripon; and now that they have become so thoroughly established the geological literature of Europe, any attempt to supersede em would be as unjustifiable as it would probably be futile. f course it is not necessary here to assert the *cosmopolitan* nature of ience, nor to insist upon the equal claims of designations, whether British or foreign origin.

The object of the present essay is to examine historically and itically, according to the principles just laid down, the terminology a certain series of deposits. Some writers, who have done me e honour to notice my papers on the Neocomian strata of the orth of England, have unfortunately so far misunderstood my ject as to represent me as introducing a new system of nomenature. On the contrary, as I now propose to show, the name *ower Greensand* had its origin in a series of mistakes and misnceptions, while the term *Neocomian* is that which must be lopted according to the law of priority, and in fact has claims of e same nature and force as those which may be urged in behalf of e term *Silurian.*

It seems to be impossible, as Webster has observed, to determine e exact date when the term *Greensand* first came into use among ologists. As is well known, the observations and even the noenclature of William Smith had, by his liberal oral communicans, become very generally known to geologists long before his iends succeeded in persuading him to publish his first map. In a ble of the strata near Bath, drawn up in 1799, Smith calls the bed immediately below the Chalk simply *Sand*, but in the table accompanying the first part of his map in 1812, he employs the term "Green Sand" for the same bed, and continues to use it in all his later works. It would appear therefore that the use of this term originated between 1799 and 1812. Smith's original observations on the strata between the Chalk and the Oolites were made in Wiltshire, a district where the beds between the Gault and the Upper Oolite are almost entirely hidden by the overlap of the Upper Cretaceous. In the study of this district he appears to have been greatly assisted by his friend the Rev. Joseph Townsend, then rector of Pewsey, who in his work "The character of Moses established for veracity as a historian," speaks of the beds below the Chalk as being successively "Green Sand," "Grey Sand," and "Red Sand." That Smith, whenever he used the term "Greensand," restricted it to the sands *immediately* below the Chalk and *above* the Gault, will be seen by a reference to his various extended Sections and County Maps, published between 1819 and 1824. When he afterwards became acquainted with the Neocomian and Wealden strata of the South-east of England, he not unnaturally referred them to several members of the Upper Oolite, considering the Kentish-rag as Portland-stone, part of the Shanklin Sands as Portland Sand, and the Weald Clay as Kimmeridge or Oxford Clay.

The author who first fairly described the succession of the beds between the Chalk and the Oolites was Thomas Webster, who, in his Letters, written in 1811, and published in 1816, in Sir Henry Englefield's "Isle of Wight," gives the following as the order of the strata in that island:—

1. Chalk.
2. Greensand and Firestone.
3. Blue Marl or Gault.
4. Ferruginous Sands.

Unfortunately, Webster confounded, under the name *Ferruginous Sands*, both the Shanklin Sand and the Hastings Sand, regarding the Weald Clay as only a subordinate stratum. It is evident, however, that both Smith and Webster, in spite of their misapprehensions concerning the beds below, uniformly and consistently applied the term *Greensand* to the sands *immediately* below the Chalk and *above* the Gault.

When, however, we turn to the works of the writers on these beds, who immediately succeeded Smith and Webster, we find the greatest confusion produced by the misapplication of the term *Greensand*. Greenough, in his Geological Map of England and Wales, published in 1816, calls all the beds between the Chalk and the Weald Clay "Blue Marl and Greensand." Dr. Buckland, in his Synoptic Table, calls both the sands above and those below the Gault, "Greensand;" while Dr. Mantell, in his "Geology of Sussex" (1822), names the former "Malm Rock" and the latter "Greensand." Sedgwick, however, in his paper in the "Annals of Philosophy" (1822), rightly follows Webster, calling the beds between the Chalk and Gault "Greensand," and including all the formations between the Gault and the Oolites as "Ironsand." By the publication, in the same year, of Conybeare and Phillips's "Geology of England and Wales," the whole subject of the nomenclature of the Lower Cretaceous became sadly involved again, for in this work the Gault of Folkestone is called "Chalk Marl," and the sands *below* "Greensand."

At the very time when the nomenclature of these deposits had thus been reduced to an apparently almost hopeless state of confusion, the true order and succession of the lower beds began to be worked out in detail by several earnest investigators. After Webster, the first in the field (according to a note of Dr. Fitton[1]) was Mr. (now Sir Charles) Lyell, who succeeded in determining the true relations of the beds in the Isle of Wight, though his results were not published at the time. In June, 1824, Webster read before the Geological Society his paper, entitled "Geological Observations on the Sea Cliffs of Hastings, with some Remarks on the Beds immediately below the Chalk," in which he established the division of the "Hastings Sand," and proposed the term *Ferruginous Greensand* for the sands below the Gault. In a second paper, published in November of the same year, Webster proposed to substitute the term *Lower Greensand* for *Ferruginous Greensand.*

In this same month of November, 1824, Dr. Fitton published, in the "Annals of Philosophy," his admirable description of the true succession of the Cretaceous Strata in the Isle of Wight and the adjoining coast of Dorsetshire, in which, however, he did not escape the prevailing error with regard to the use of the word "Greensand." In an additional note, in the next month's number of the same journal, he suggested the names of "Merstham Beds" for the sands *above* the Gault, and "Shanklin Sands" for those *below.*

In a reply to Dr. Fitton's paper, contributed by Webster to the "Annals of Philosophy," in January, 1825, the justice of the classification is admitted, but the nomenclature is demurred to. In place of the names proposed by Dr. Fitton, Webster suggests that the term "Greensand" should be used only in its original and proper sense for the sands above the Gault, while those between the Gault and Weald Clay should be called "*Upper* Ferruginous Sands," and those below the Weald Clay "*Lower* Ferruginous Sands."

We thus see that the name *Lower Greensand,*[2] which was proposed by Webster in November, 1824, was, *on further consideration,* withdrawn by its author in January, 1825. Unfortunately, this highly objectionable and misleading name appears to have been seized upon by the members of the Geological Society as a means of compromising the differences of opinion of the two illustrious leaders, Webster and Fitton, and thus a term, characterised by the illogicality inherent to such compromises, obtained an extensive currency. In Murchison's paper on parts of Sussex, Hants, and Surrey,[1] read before the Geological Society in December, 1825, the beds in question are called "Lower Greensand, Carstone, or Shanklin Sands." In Martin's paper on the vicinity of Pulborough[2] (read March, 1827), and in his "Geology of West Sussex" (1828), the whole series of beds between the Gault and Weald Clay is called "Shanklin Sand," the upper portion being described under the name of "Ferruginous Sands," while the term "Lower Greensand" is restricted to the lower portion.

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[1] Annals of Philosophy (new series), vol. viii., p. 458.

[2] The term *Lower Greensand* originated in a mistaken notion that the beds above and below the Gault had intimate relations with one another, and that they might therefore be made to constitute a single formation, "the Greensand," of which the Gault was to be considered the middle, and a subordinate member. The inapplicability of the name, even in the typical districts of Kent and the Isle of Wight, has frequently been pointed out. The misapprehension which must arise from the use of *parallel* terms for a subordinate bed (seldom more than 100 feet thick) and a great formation (nearly 1,000 feet thick) is evident. To give this bad name, "Lower Greensand," an extended meaning, by applying it to the Speeton Clays of the North of England, or to the great variety of beds of the same age on the Continent, would make matters infinitely worse.

On the first suggestion of the term "Lower Greensand," Dr. Fitton pointed out some of the very forcible objections to its use,[3] and though, in his great work on the strata between the Chalk and the Oxford Oolite (read in 1827, but not published till 1836), he follows what had then become the common custom, he accompanies the use of the term with a strong protest.[4] In 1845 the same author writes as follows:—He "had long since stated the objections to which the name *Lower Greensand* was exposed, but thought it expedient in 1835 to adopt that term, on the ground of its universal employment in England, and its very general reception on the Continent. On this ground he thinks that this name ought, for the present, to be retained. If, hereafter, a change be thought desirable, he conceives that the new denomination should be taken from the Isle of Wight, where this portion of the Subcretaceous Rocks was first distinguished, and where the sections on the coast are remarkable for their distinctness; and if such a case should arise, he suggests the name of *Vectine* for the strata now called Lower Greensand, from the ancient name of that island, *Insula Vectis* of the Romans."[5] If I do not here quote any particular passage from the valuable series of contributions on this subject from the pen of Mr. Godwin-Austen, it is because *almost every page* of those memoirs exposes the viciousness of the term "Lower Greensand," and indicates the necessity for a change.[6]

While such varied complications and confusion had arisen in this country in the matter of the classification and nomenclature of the Subcretaceous strata, the geologists of Switzerland and France were gradually working out the true relations of the fine development of the same formation on the flanks of the Jura. Passing over the early researches of Borguet, de Saussure, and Von Buch, each of whom made valuable contributions to the subject, and to some extent anticipated later and fuller discoveries, our attention is particularly attracted by the labours of Auguste de Montmollin, of Neuchâtel. This able geologist was engaged, during the years 1825-7, in closely studying the rocks (then supposed to belong to the Upper Oolite) in the neighbourhood of his native town; and in 1828 was able to carry a considerable collection of their fossils to Paris, and to compare them with the palæontological collections of M. A. Brongniart. He was thus led to the conclusion that the Swiss fossils had close affinities with those of the Lower Cretaceous, and that the beds of Neuchâtel were *near* in age to the Lower Greensand. At least as early as 1833 M. de Montmollin read before the "Société des Sciences Naturelles de Neuchâtel" his celebrated "Mémoire sur le terrain Crétacé du Jura," though it was not published until 1835, while the accompanying map did not appear until 1839. Some of the earlier labours of Agassiz were devoted to the study and description of the fossils of these beds, and the discussion of the relations of the strata themselves.

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[1] Trans. Geol. Soc., second series, vol. ii., p. 97.

[2] Proc. Geol. Soc., vol. i., p. 19.

[3] Annals of Philosophy, new series, vol. viii. (1824), p. 461.

[4] Trans. Geol. Soc., 2nd series, vol. iv., p. 103.

[5] Quart. Journal Geol. Soc., vol. i., p. 189.

[6] See, especially, "On the Geology of the South-east of Surrey." Proc. Geol. Soc. iv., p. 167, 196; and "On the Age and Position of the Fossiliferous Sands and Gravels of Farringdon," Quart. Journal Geol. Soc., vol. vi., p. 454.

In 1836 MM. Voltz and Thirria published their "Mémoire sur le terrain Jura-crétacé de la Franche-Comté," in which they point out that the beds in question form either the lower part of the Greensand formation, or else constitute a distinct formation, situated between the Jurassic and Cretaceous.

In consequence of the differences of opinion which existed on the subject of the classification of the beds of the Jura, two special conferences of geologists took place—that of Neuchâtel in 1834, and that of Besançon in 1835. At the latter of these M. Jules Thurmann pointed out the strong reasons which existed for considering the strata in question as constituting a new geological horizon, and proposed for it the name *Néocomien*, from the Latin name (Neocomum) of the town about which they are so well developed, and where they were first studied. This happy suggestion was at once adopted by M. de Montmollin and the other geologists present, and the term Néocomien soon obtained an extensive currency in France, Switzerland, and Germany.

A year or two later the existence and characters of beds of the same age on the eastern side of the Paris basin were described almost simultaneously by MM. La Joye, Leymerie, Royer, and Cornuel.

In the typical district of the Jura the Neocomian series is not complete in its upper part. For the higher beds, not represented in that district, D'Orbigny proposed the name *Aptien*; and later he separated the upper part of the Neocomian of the Jura, under the name *Urgonien*. D'Archiac, however, has well shown, in the fourth and fifth volumes of his "Histoire des Progrès de la Géologie," that the Aptien, Urgonien, and Neocomien *étages* of D'Orbigny are but portions of one great formation, to the whole of which the term Neocomian is properly applied. It is not necessary here to pass in review all the terms—such as Rhodanien, Barrémien, Valanginien.

Dubuisien, &c.—which have been proposed for portions of this formation, and which are not destitute of a *local* value.[1]

Two important attempts to dismember the great Neocomian formation have, however, been made since the time of D'Orbigny, and these demand our attention. In 1858 M. Marcou, who has done so much for the elucidation of the structure of the French Jura, argued that the term Neocomian ought to be applied only to the beds originally described by de Montmollin; and he showed, at the same time, that the palæontological affinities of D'Orbigny's Urgonien and Néocomien *étages* were so close that they could only be regarded as constituting a single formation. On the other hand, M. Lory's admirable researches in Dauphiny have made known to us the fact that strata, before considered as typical Aptien, are actually interstratified with the true Urgonien. In consequence of this discovery, MM. Coquand, Cornuel, and several other distinguished French geologists argue that the Aptien and Urgonien should be joined together to constitue one formation (the Urgo-Aptien), while the beds below (Néocomien of D'Orbigny) should form a second.

Believing, as we do, with M. Marcou, in the close palæontological affinities of the Urgonien and Néocomien *étages* of D'Orbigny, and equally, with M. Lory, in the no less close relation of the Aptien and Urgonien, we are led to follow d'Archiac, and to regard the whole of these three divisions as constituting one grand formation. This formation, or system, in places includes nearly 9,000 feet of marine strata, and over wide areas is separated by *grand unconformities* alike from the Cretaceous above and the Jurassic below. It has an *extensive* and, in many respects, a *peculiar* fauna, many of the species of which pass from the bottom to the top of the series, while but very few indeed transgress its limits. The Neocomian does not present closer relations with the true Cretaceous than it does with the Jurassic, with each of which it is in every way worthy to rank as an independent "system."

The use of the term Neocomian, to include the three *étages* (Aptien, Urgonien, and Néocomien) of D'Orbigny, which we advocate, is that which is almost universally adopted by the geologists of Switzerland —by MM. Pictet, Renevier, and others, who have done so much to illustrate the formation and its fauna in their own country. It is to be regretted, however, that these geologists introduce some confusion into their writings by the use, at the same time, of the term *Neocomian proper*, for a small portion of the formation (marnes d'Hauterive). In France the same comprehensiveness is attached to the term as was done by the late M. D'Archiac by a considerable number of geologists, foremost among whom stands M. Hébert, who in several papers has ably defended this extended application of the term.

For the same system of strata the term *Hils* has been used in Germany, and the name *Biancone* in Italy, but both of these are of later date than the name Neocomian.

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[1] On this subject I would refer the reader to Mr. Davidson's valuable "Notes on Continental Geology," in the Geological Magazine for 1869.

We have seen in the preceding pages that the term "Greensand" was originally applied by Smith and Webster to the bed now known as *Upper Greensand*, and that, through the excusable, but most unfortunate, misconceptions of succeeding writers, it came to be applied to a formation of much older date; also how, in an ineffectual attempt to get rid of the confusion which had arisen, the words Upper and Lower came to be added to the term. We have also seen the great objections there are to the term "Lower Greensand," and the attempts which have been made in this country to find a substitute for it. Lastly, we have followed the labours of those geologists in Switzerland and France, who, studying the same formation in its more complete development, have suggested a name in every respect suitable—one against which no valid objection has ever been urged, and which has taken a firm root in geological literature.

It is for these reasons that we believe that the term Neocomian has claims before all others to be applied to the great system of strata between the Cretaceous and the Oolites. Terms like Silurian and Neocomian are the monuments of great epochs in the history of geological discovery, and the former is not more closely associated with the achievements of Murchison than is the latter with the labours of de Montmollin.

NOTICES OF MEMOIRS.

I.—On the Surface-Geology of the Basin of the Great Lakes, and the Valley of the Mississippi. By Prof. J. S. Newberry, M.D.

[Annals of the Lyceum of Nat. Hist., New York, Vol. IX., 1869.]

THE area under consideration is bounded on the north by the Eozoic highlands of Canada, on the east by the Adirondacks and Alleghanies, and on the west by the Rocky Mountains.

Marks of glacial action are abundant in the northern half of the area, and where the nature of the rocks is such as to retain inscriptions, there numerous furrows are found, having a general north and south direction.

In the southern half of the Mississippi valley the evidences of glacial action are entirely wanting, and there is nothing corresponding to the wide-spread Drift deposits of the north. The points of chief interest are the proofs which it furnishes of erosion on a stupendous scale.

Some of the valleys and channels (in the northern area) which bear the marks of glacial action—evidently formed or modified by ice, and dating from the Glacial period or an earlier epoch—are excavated far below the present lakes and water-courses which occupy them. These valleys form a connected system of drainage, at a lower level than the present river system.

Lakes Michigan, Huron, Erie, and Ontario, are basins excavated in undisturbed sedimentary rocks. An old excavated, but now filled up channel connects Lakes Erie and Huron. Another trough runs south from Lake Michigan—filled with clay, sand, trunks of trees, etc.—which has been penetrated in one place to a depth of 230 feet.

The borings for oil in the valleys of the Western rivers have enabled Professor Newberry not only to demonstrate the existence of deeply buried channels of excavation, but in many cases to map them out. He points out the importance of a knowledge of these old channels in the improvement of the navigation of our larger rivers, as this may in many cases prove valuable in constructing canals, when millions of dollars might be expended in rock excavation.

Upon the glaciated surfaces of the solid rocks are found a series of unconsolidated materials, generally stratified. These are the Drift deposits, which occur in the following (ascending) order:—

1. The Erie clays of Sir W. E. Logan. They consist of blue and red clays, finely stratified, with drifted coniferous wood and leaves, and containing in some places beds of gravel and boulders. In Ohio these clays are nearly 200 feet in thickness. They fill the old channel which formerly connected lakes Erie and Huron; here they are over 200 feet thick.

2. Above the Erie clays are Sands of variable thickness, less widely spread than the clays. They contain beds of gravel, and near the surface water-worn teeth of Elephants have been found.

3. Upon these clays, sands, and gravels, are scattered boulders of all sizes, composed of granite, diorite, and dolerite, mica-slate, etc., generally traceable to the Eozoic area north of the lakes. There are also many balls of native copper from the copper district of Lake Superior.

Above all these Drifts, and more recent than any of them, are "lake-ridges," embankments of sand, gravel, sticks, leaves, etc., which run rudely parallel to the present margin of the lakes, when highlands lie in the rear. The author regards them as true lake-beaches.

Professor Newberry gives some theoretical deductions regarding the history of these deposits, and then discusses the origin of the Great Lakes. Some of them are embraced in the folding of the Eozoic rocks, and fill synclinal troughs; but most of the series, from Great Bear Lake to Lake Ontario, are basins of excavation in the Palæozoic plain that flanks in a parallel belt the Laurentian area. The bottoms and sides of the lake-basins, wherever exposed to observation, if composed of resistant materials, bear indisputable evidence of ice-action, proving that these basins were filled by moving glaciers in the last ice-period. He considers that no other agent than glacial ice is capable of excavating broad, deep, boat-shaped basins, like those which hold the lakes. This theory, it is hardly necessary to say, is in accordance with that which was first promulgated by Professor Ramsay, and which, although it met with disfavour when it was first started some time since (1862), has certainly been gaining ground, though slowly, and it seems probable that the glacial origin of rock-basins occupied by lakes will ere long be generally accepted.—H. B. W.

II.—The Geological Relations of the Alpine Flora of Great Britain. By the Rev. Jas. M. Crombie.

(A paper read before the Geologists' Association of London.)

IN this paper Mr. Crombie discusses the origin of the Alpine (or Boreal) Flora of Great Britain, showing that it is directly due to a past geological condition of our island. This Alpine Flora is met with upon our higher mountains; but only on the higher ranges of Scotland, on the lofty and extensive Grampians, does it occur in great plenty and variety.

The limits within which the plants are usually found are from about 1,506 to 4,406 feet (the summit of Ben Nevis). This space has been divided into certain zones, both physically and botanically distinct from each other, and these are applicable to all the loftier mountains, making due allowance for diversity of situation, mineralogical structure, etc.

The flora of each is so similar in its main features as clearly to betray a common origin and a similar mode of distribution. Between our Alpine Flora and that of Scandinavia there is a great similarity, and the author considers that the boreal forms of Great Britain were derived from it.

He agrees with the late Professor Edward Forbes that the distribution of this Alpine Flora was effected during the Glacial epoch, which, indeed, the character of the plants themselves renders most probable.

III.—Proceedings of the Bristol Naturalists' Society. Vol. IV. For the year 1869.

IN their Report of 1869, the Council of the Society regret to state that, although a fair amount of work has been done during the year, yet there has been but a poor attendance of members, both at the general Evening Meetings, and at the Summer Excursions. The number of members has also decreased from 215, in 1868, to 167, in 1869; in addition to which however there are seven Lady Associates.

In the present volume there are eleven papers, including some on Geological subjects.

There is an Analysis of the Report presented by the late Prof. W. Hopkins to the British Association, "On the Theories of Elevation and Earthquakes," by the President of the Society, Mr. W. Sanders, F.R.S., etc.

The Rev. Canon Moseley, F.R.S., Vice-President, communicates a paper "On the Cause of the Descent of Glaciers."

He considers that a glacier would not by its weight descend. As glaciers move faster by day than by night, and faster in summer than in winter, he maintains that it must be the variation in the amount of solar heat which causes the changes of glacier motion.

His theory is, that dilatation and contraction of the ice, produced by the passage into it and withdrawal from it of the sun's rays, is the proximate cause of the descent of glaciers.

REVIEWS.

I.—ON THE LIMITS OF THE JURASSIC AND CRETACEOUS FORMATIONS.

By F. J. PICTET.

[Rapport fait à la session de 1869 de la Société Helvétique des Sciences Naturelles.]

IT has been generally admitted that the Kimmeridgian and Portlandian stages form everywhere the upper limit of the Jurassic period, and that the Neocomian (including the Valangian stage) form the lower limit of the Cretaceous period. These limits appear reasonable from the existence of intermediate freshwater deposits (Wealden).

Late researches have tended to render somewhat indefinite the boundary between these periods, and numerous discussions have taken place, of which the author gives a résumé in the present sketch.

Oppel, in 1865, determined the existence of certain strata, characterised by a very rich fauna, between the upper Jurassic (Kimmeridgian stage) and the Neocomian, to which he applied the name Tithonic.

The succession of the beds is not contested. Numerous published works show the succession of faunas has been the same at many points far distant from one another, and it may be considered as a fact that from the Carpathians to the Mediterranean, in all places where the Tithonic stage has been met with, the series is disposed as follows:—

1. Neocomian stage (proper).
2. Valangian stage, and Marls with *Belemnites latus*.
3. Limestone of Berrias.
4. Tithonic stage.
5. Bed with large specimens of *Aptychus*.
6. Jurassic fauna with *Ammonites tenuilobatus*.

The limit of the Jurassic and Cretaceous periods may be drawn between stages 4 and 5, or between 5 and 6. But M. Pictet asks, is it not possible that there has been no interruption between the two periods?

The question, he maintains, can only be solved by a general comparison of the beds in question over a large area.

Reviewing the researches of Palæontologists in various localities, he gives the following arrangement to show the succession of beds where the Tithonic stage is well developed:—

1. Lower Neocomian stage and Limestone of Berrias (*Terebratula diphyoides*).
2. Upper Tithonic fauna, or Limestone of Stramberg (*Terebratula janitor*).
3. Lower Tithonic fauna of Rogoznik, Blue Marble of the Apennines, and probably the Limestone with *Terebratula diphya* of the Tyrol.
4. Fauna with *Ammonites tenuilobatus*.

Nos. 3 and 4 have characters eminently Jurassic; No. 2 is rather *Cretaceous;* and in No. 4 are found the usual forms of this period.

The line of separation between the two periods has been placed between stages 2 and 3, but M. Pictet regards it as a very feeble limit.

The four stages are bound together by great palæontological analogies. Several species pass undoubtedly from No. 1 to No. 2, from that to No. 3, and from No. 3 to No. 4. Nos. 2 and 3 in particular have about one-third of their species in common! He, however, suspends judgment until new sections are known and new local faunas worked out, which he hopes may determine the question. A minute description of the fauna, with *Terebratula diphya*, of the Tyrol, will soon be ready, and he expects that the results of observations by M. M. de Verneuil and Ernest Favre in Andalusia, will supply some desiderata towards a definite solution.

M. Pictet concludes with some theoretical reflections on the manner in which these researches must be received and discussed. He believes that the development and succession of beings has been, and still is, under the control of laws perfectly regular, and that the faunas have been modified more or less gradually, and with a certain slowness, under the influence of varied circumstances, like those which bring about analogous effects in modern seas.

But as these circumstances are not identical at all times, nor in all places, it is not at all probable that changes happen exactly in the same manner in all geological basins.

The history of the succession of life must consequently be very complex, and modified by local causes; it could not be drawn up very simply, nor would it be applicable to all cases.

M. Pictet makes a few remarks on the use of the word *normal*, objecting to its application to particular beds in the "Anglo-French basin," in which according to some Naturalists are to be found the normal succession of stages; while the beds in other localities, which are not rigorously identical in character, are considered abnormal.

If by chance, as M. Merian has remarked, the first development of geology had taken place elsewhere, the classification would doubtless have been different. Breaks that in the "Anglo-French basin" are very clear, would in other places be represented by a continued succession of beds, and *vice versa*.

M. Pictet remarks on the indefinite character of Zones. They are useful, but they should not be characterized by one or two isolated fossils, but rather by an assemblage of forms.

Recent discoveries ever tend to soften down the hard lines that were supposed to separate our great formations. The limits assigned to them are mere inventions of science, useful in their way as points of reference, sometimes indicating local breaks, but never an index of change for localities.

The passages of the Devonian into the Carboniferous are now well established, the Rhætic beds fill up the gap between the Trias and Lias, new freshwater deposits discovered by M. Matheron connect the Cretaceous and Tertiary periods, and the latter merges insensibly into the Quaternary and Modern periods.

II.—THE VALLEY OF THE POORNA RIVER, WEST BERAR. By A. B. WYNNE, F.G.S., &c.

[Records of the Geological Survey of India, No. 1, 1869.]

THE Poorna (or Poona?) Valley, in Central India, lies between longtitudes 76° and 78° east, and is traversed by the 21st parallel of N. latitude. It is about 124 miles in length, from its upper or eastern end to where it passes into the larger valley of the river Taptee. In width it varies from thirty to forty miles, on an average. It is bounded on the south by the Adjunta ghâts, an abrupt scarp of the Deccan plateau, into the usual steppe character of which these ranges pass imperceptibly; while on the north are the bold and varied escarpments of the Gawilghur range. These latter mountains are intersected by steep glens and wide valleys, sometimes presenting nearly vertical precipices of great height, in places probably from 1,000 to 1,200 feet.

The hills and portion of the valley south of the Poorna river consist of Trap, similar to that of the Deccan. The stratification is very perceptible, and nearly always horizontal. The Gawilghur range is mainly composed of hard basaltic beds, amygdaloid, and soft traps. A great fault, with a down-throw to the south, crosses the country in an east and west direction, close to the foot of this range, and brings the Trap against the underlying Mahadeva or Bâgh (Tanda) sandstones. These sandstones are soft or coarse, white, and even-grained, and would, in Mr. Wynne's opinion, furnish good building stone.

Impressions of plants have been observed in some of the flaggy beds, and numerous small univalves have been met with in shales and limestones belonging to these Mahadeva beds.

Mr. Wynne describes at some length the alluvium of this valley, which appears as a great plain. The ground in places is undulating, while the Trappean rocks are here and there exposed at the surface. In every part of the alluvium calcareous conglomerate is of common occurrence. It occasionally contains fragments of bones and teeth of ruminants. Small freshwater shells are not uncommon in the deposit. They appear to belong to existing species of *Melania*, *Paludina*, *Bithynia*, *Lymnæa*, *Planorbis*, and *Unio* (?).

Much of the Poorna alluvium produces efflorescences of salts, chiefly of soda; and in many places the wells sunk in it are brackish or salt. Wells are specially sunk for obtaining common salt, and some of them are from 120 to 130 feet in depth. They are sunk through yellow clay, then reddish clay, and, below this, into a coarse sand or fine gravel, from which the water issues with great force.

The alluvium is of considerable depth. In places it may exceed 150 feet.

Whether the whole of this alluvium was deposited in a lake, or by the river, travelling from side to side of the valley, under other conditions that at present obtain, Mr. Wynne considers it difficult to say. A former estuarine condition of the area, or a large lake, is indicated by the salt-bearing beds; but the even, though interrupted, surface of the alluvium, he thinks, is against the probability of its having been deposited by the Poorna under existing conditions.

Laterite occurs in several places.

The cotton or black soil, which occurs largely in the Poorna valley, as is usual in trappean districts, has no geological peculiarity, and has therefore not been treated of by Mr. Wynne. He remarks, that to its development, and to the fertile nature of soils derived from the Trap, may doubtless be traced the name which this country has obtained as a cotton-producing district.—H. B. W.

III.—TRANSACTIONS OF THE EDINBURGH GEOLOGICAL SOCIETY. Vol. I. Part III. 8vo. 1870.

THE papers contained in this Part are those read before the Society between November, 1868, and June, 1869—and with them is completed the first volume of the Society's Transactions. The whole is well printed, and illustrated with many plates and wood-cuts. Most of the papers have been noticed previously in the GEOLOGICAL MAGAZINE, with the exception of four read on the 6th of May, 1869.

1. Note on the occurrence of *Actinocrinus pulcher* in the Upper Silurian Flag of Denbighshire. By D. W. Roberts, M.B., etc. The author records a new locality (Galt-y-celyn, Derwen) for this rare Encrinite, which hitherto had only been found in two places in North Wales.

2. On two River Channels buried under Drift, belonging to a period when the land stood several hundred feet higher than at present. By James Croll. The author described an ancient river channel buried under drift, extending from Kilsyth to Grangemouth, which has been discovered through means of borings for minerals. The journals of these borings were collected for the purpose of ascertaining the depth and character of the surface deposits of the country; and it was while examining these that the incidental discovery was made of a deep preglacial, or perhaps interglacial, trough or hollow, extending from the Clyde, above Bowling, by Kilsyth, to the Firth of Forth, near Grangemouth. It was clear that this hollow was not due to a fault, but to denudation, as the strata which it cuts through were found to be intact and unbroken beneath, proving that it had been cut out of the solid rock. The author thinks that the western half of this great hollow, extending from the watershed at Kilsyth to the Clyde, is also an old river channel, probably the ancient bed of the Kelvin. He concluded that this hollow had been cut out by running water in the form of rivers, when the land stood higher than now. These rivers, starting from the present watershed of the district near Kilsyth, would run, the one westward, flowing along the valley of the Kelvin, into the Clyde near Bowling, and the other eastward, along the present course of the Bonny Water, till it entered the Firth of Forth near Grangemouth. The geological state of this ancient river channel is shown by the deepest bore at Grangemouth to be either just before

or shortly after the beginning of the glacial epoch; which conclusion is confirmed by the deepest bore in the western portion of the hollow. The chief geological value of this discovery consists in the evidence it affords that at the time when water flowed down this ancient river channel into the sea the land must have stood nearly 300 feet higher than at present. The surface of the land at Grangemouth is only 12 feet above the level of the sea; and as the bottom of this old river channel is 273 feet below the surface, it is evident that the land must have stood at least about 260 feet higher than at present. It is satisfactory thus to find on land a confirmation of what has long been inferred from the mammalian and other remains found in the bed of the German Ocean, the English Channel, and other parts, that at a very recent period our island must have stood several hundred feet higher than now, and formed part of the great eastern continent, which then included in its area the present isolated lands of Great Britain and Ireland.

3. On the Discovery of a "Sand-dyke," or Old River Channel, running North to South, from near Kirk of Shotts to Wishaw, Lanarkshire. By Robert Dick. Mr. Dick first discovered this old river bed, or "sand-dyke" in mining language, in the Virtuewell coal workings of No. 27 pit, connected with the Omoa Iron Works. The level to the north-west had not been driven far from the pit bottom when the coal was observed to become "rusty" or weathered in appearance. The "joints" of the coal were open, and the roof of the mine became brittle as the miners advanced. These signs indicated the termination of the coal-seam, and when the "level" pierced the "boss" a finely-grained sand-bed was exposed. The attempt to reach the coal-seam, which was known to exist at the opposite side of this "sand-dyke," was successfully made, which demonstrated the existence of an old river course, running through the strata in this district, and forming a deep glen at a period before the deposition of the Boulder clay.

4. Notes on Chemical Geology. By Andrew Taylor. Mr. Taylor drew attention to a number of curious observations, indicating a relation betwixt terrestrial magnetism, underground temperature, and the sun's action.

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. March 23rd, 1870.—Warington W. Smyth, Esq., M.A., F.R.S., Vice-President, in the Chair. The following communications were read:—

1. Professor Huxley communicated a letter received by him from Dr. Emanuel Bunzel, of Vienna, giving a short account, illustrated with figures, of the posterior portion of a skull obtained by Professor Suess from a coal-mine of Upper Cretaceous (Gosau) age. Dr. Bunzel stated that at the first glance this skull appeared to possess Reptilian characters, but that the convexity of the occiput, and its gentle passage into the roof of the skull, the presence of a transverse

ridge in the occipital region, the absence of sutures, the globular form of the condyle, and some other peculiarities, prevent the animal to which this skull belonged from being referred to any known order of Reptiles. The author compared this fragment of a skull with that of a bird, and suggested the establishment of a new order of fossil Reptiles (*Ornithocephala*), closely related to Prof. Huxley's *Ornithoscelida*. He proposed to refer his fossil to a new genus, which he named *Struthiosaurus*.

2. "On the Discovery of Organic Remains in the Caribean Series of Trinidad." By R. J. Lechmere Guppy, Esq., F.L.S., F.G.S.

The author described the rocks of the "Caribean Group" as consisting of gneiss, gneissose, talcose, and micaceous slates and crystalline and compact limestones, and remarked upon the probable distribution of rocks of the same series on the continent of South America. In Trinidad the uppermost member of the series is a compact dark blue limestone, which contains obscure but very abundant fossils; in the subjacent clay-slates and quartz rocks calcareous strings and bands, containing more distinct traces of organisms, occur. The author believed that he had detected an *Eozoon* (which he called *E. caribeum*), a *Favosites* (named *F. fenestralis*), a Coral, and fragments of Echinoderms. He considered it probable that the Caribean Series was pre-Silurian.

Discussion.—Dr. Carpenter, from the slight examination he had been able to make of the fossils, was unwilling to speak decidedly about them. There was, however, no doubt of numerous organic remains occurring in the rocks, and among them serpuline shells and echinoderms. As to the supposed *Eozoon*, he had not been able to recognize any of the characteristics of that fossil; and by treating the Trinidad specimens with acid, he found no traces of structure left, and yet there had not been sufficient metamorphism to destroy other organisms. In some dredgings from the Ægean Sea he had found fragments of echinoderms and other organisms, in which a siliceous deposit had replaced the original sarcode in the same manner as had occurred in the Canadian *Eozoon*, thus proving the possibility of this form of substitution, which had been warmly contested.

Mr. Tate offered some suggestions as to the age of these beds, which were certainly older than Neocomian. The Californian gold-bearing beds appear to be Jurassic. Similar beds occurred in New Mexico, Guatemala, and were observed by him in Nicaragua and Costa Rica. These present lithological and mineralogical affinities to the Venezuelan and Trinitatian metamorphic series, and were conjectured to be of the same age.

3. "On the Palæontology of the Junction-beds of the Lower and Middle Lias in Gloucestershire." By Ralph Tate, Esq., A.L.S., F.G.S.

The object of this paper was to show that the attachment of the zone of *Ammonites raricostatus* to the Lower Lias, and that of *A. Jamesoni* to the Middle Lias, harmonizes with the distribution of the organic remains: 50 species were catalogued from the united zones of *A. oxynotus* and *A. raricostatus*, 8 of which pass up into the Middle Lias, whilst 13 occur in the lower horizons; 115 species were enumerated as occurring in the zone of *Ammonites Jamesoni*, 60 of which pass to higher zones, whilst 11 made their first appearance in the Lower Lias; the number of species common to the contiguous zones being 14.

The author inferred that, as the conditions of depth and deposit of the upper part of the Lower Lias are repeated in the lower part of the Middle Lias, accompanied by a total change in the fauna, a break in the stratigraphical succession existed between the Lower and Middle Lias. This view is supported by the fact of the numerical decrease of species in passing up through the several stages of the Lower Lias, and that of the introduction of many new generic types with the zone of *Ammonites Jamesoni*. Many new species were described.

DISCUSSION.—Prof. Boyd Dawkins had attempted to test these Liassic zones as a means of classification of the rocks in Somersetshire, and the result had been that he had been unable to accept them as fixing hard and fast lines of demarcation; for he had found three of the distinctive Ammonites together in one bed. On our present shores the change of one form of molluscan life for another seemed to take place in limited areas, and to be dependent on some slight variation of physical conditions rather than on any great change. He had not been able to trace any stratigraphical unconformity between the Middle and Lower Lias in many parts of England, whatever might be the case in Gloucestershire.

Mr. Tate, in reply, gave an account of the manner in which he had arrived at his conclusions, and expressed his assent to the view that Ammonite-zones were only of value over limited areas, but considered that a triple division in the Lower, and a dual division in the Middle Lias were well established on palæontological and lithological features. The break which he had pointed out was palæontological rather than stratigraphical, though the one might be inferred from the other.

4. "Geological Observations on the Waipara River, New Zealand." By T. H. Cockburn Hood, Esq., F.G.S.

In this paper the author described the general features of the locality from which he has obtained bones of *Plesiosaurus*, *Ichthyosaurus*, and *Teleosaurus*. The bones were not obtained *in situ*, but from large boulders and blocks scattered in the ravines of the Waipara and its tributaries.

DISCUSSION.—Prof. Boyd Dawkins remarked on the presence of Crocodilia in New Zealand being proved by the procelian vertebra.

5. R. H. Scott, Esq.. F.G.S., communicated an extract from a letter addressed to him by M. Coumbary, Director of the Imperial Observatory of Constantinople, containing an account received from M. L. Carabello of the reported fall of a large meteorite, near Mourzouk, in the district of Fezzan, in lat. 26° N., and long. 12° E. of Paris. It fell on the evening of the 25th December last, in the form of a great globe of fire, measuring nearly a metre in diameter. On touching the earth it threw off strong sparks, with a noise like the report of a pistol, and exhaled a peculiar odour. It fell near a group of Arabs, who were so much frightened by it that they "immediately discharged their guns at this incomprehensible monster."

II. April 13th, 1870.—Sir P. de Malpas Grey Egerton, Bart., M.P., F.R.S, Vice-President, in the chair. The following communications were read:—1. A letter from Dr. Gerard Krefft, dated Sydney, 29th of January, 1869, accompanying a model of the left lower incisor of *Thylacoleo carnifex*, Owen, and the original fragment from which the model was made. Dr. Krefft also referred to the fossil remains of Herbivorous Marsupials in the Museum at Sydney, which included, according to him, besides a great number of Wombats (*Phascolomys*), many wombat-like Kangaroos or Wallabies (*Halmaturus*). He proposed to divide the Kangaroos into the following groups:—

1. *Macropus*, dentition as in *Macropus major*.
2. *Halmaturus*, with the premolar permanent, divided into two sub-groups:—
    a. True Wallabies, with the premolars long, narrow, and compressed, and the rami of the lower jaw but slightly anchylosed.
    b. Wombat-like Wallabies, with the premolars compact, rounded, and molar-like, and the rami of the lower jaw firmly anchylosed.

Illustrative sketches and photographs accompanied this paper.

Discussion.—Prof. Owen remarked upon the importance of the researches made by Dr. Krefft and Prof. Thomson. No traces of man had been found. The numerous remains of Mammals, especially the Herbivorous species, had doubtless been carried into the caves by *Thylacoleo*.

Prof. Busk inquired on what evidence Prof. Owen decided that the tooth of *Thylacoleo* was that of a Carnivore.

Prof. Owen indicated the remarkable compression of the tooth, and the absence of the spatulate form proper to the Kangaroos, as characteristic of *Thylacoleo*, and indicative of carnivorous habits.

Mr. W. Boyd Dawkins stated that *Thylacoleo* was most closely allied to *Plagiaulax*, which was probably a true Herbivore. He indicated the importance of the question, as, if *Thylacoleo* were a Carnivore, *Plagiaulax* would be one also.

Prof. Owen remarked that *Plagiaulax* was also a Carnivore. The premolars resembled the small tubercular molars of the Hyænas, Felidæ, etc. The anterior tooth, associated with the small tubercular tooth, was compressed and sharp pointed. The low condyle, forming part of the angle of the jaw, was such as occurs in *Thylacinus*.

Dr. Duncan remarked that it is by no means necessary that all Carnivorous Mammals should be formed upon the same type, and that he did not see why there should not be a carnivorous form of the Kangaroo type.

The Chairman said that the settlement of these questions must now be postponed until we obtain further materials. He mentioned the discovery by Dr. Krefft, in the interior of Australia, of a species of fish resembling *Lepidosiren*, and possessing singular affinities to some of the Devonian fishes.

2. "On the Fossil Remains of Mammals found in China." By Prof. Owen, LL.D., F.R.S., F.G.S.

The specimens of teeth described by the author were obtained by Robert Swinhoe, Esq.. late H. M. Consul at Formosa, chiefly by purchase in the apothecary's shops at Shanghai. They included two new species of *Stegodon* (named *S. sinensis* and *S. orientalis*), a new *Hyæna* (*H. sinensis*), a new *Tapir* (*Tapirus sinensis*), a new *Rhinoceros* (*R. sinensis*), and a species of Kaup's genus *Chalicotherium* (*C. sinense*). The author remarked that the whole of these teeth presented an agreement in colour, chemical condition, and matrix, which led to the conclusion that all belonged to the same period. But for the presence of the *Chalicotherium*, they would have been referred either to the Upper Pliocene or the Post Pliocene period. The author did not consider that the occurrence of one Anoplotherioid species need affect the determination of the age of these fossils, especially as *Chalicotherium* departs in some respects from the type genus *Anoplotherium*, and is not known from deposits older than the Miocene.

Discussion.—The Chairman called attention to the remarkable association of forms among the fossils described by Prof. Owen.

Prof. Busk remarked that the materials at command seemed to him insufficient for the establishment of new species. He observed that the distinctive characters of *Stegodon sinensis* appeared to be very slight, and that the *Hyæna* was probably *H. spelæa*. The tooth of *Rhinoceros* might be a milk-molar of *R. sumatranus*.

Mr. Boyd Dawkins suggested that, as the specimens were obtained from apothecaries, there was no evidence of the contemporaneity of the fossils.

Mr. H. Woodward stated that Mr. Swinhoe had himself obtained a series of these fossils from a cave many miles inland, he believed on the course of the Yang-tse-kiang. Mr. Woodward also called attention to Mr. Hanbury's paper on Chinese Materia Medica, in which many fossil teeth of mammalia are noticed.

Prof. Owen, in reply, stated that great quantities of the fossils had passed through his hands, and that he had selected for description those which, from their minute agreement in chemical and other characters, might justly be inferred to be derived from caves of the same age.

3. "Further discovery of the Fossil Elephants of Malta." By Dr. A. A. Caruana. Communicated by Dr. A. Leith Adams, F.G.S.

The author described a new locality in Malta in which the remains of Elephants had been found recently—the Is-Shantiin fissure at the entrance of Micabbiba. It was filled with a compact deposit of red earth, containing fragments of limestone, many teeth and fragments of bones of Elephants, associated with bones of large birds. The author found three small shark's teeth, and a small tooth which he regarded as belonging to *Hippopotamus*. He indicated the nature of the teeth and bones of Elephants found by him in the newly discovered fissure. The whole of the five localities in which ossiferous fissures have been discovered are in the same part of the island; and the author concluded, with some remarks upon the geological conditions under which the remains of mammalia must have been accumulated, and upon the probability that a connexion then existed between Malta and Africa.

In a note appended to the paper, Dr. A. Leith Adams stated that the supposed tooth of *Hippopotamus* was a germ true molar of one of the pigmy elephants, and that the shark's teeth have probably been derived from the Miocene deposits.

Discussion.—Prof. Busk remarked that there was no doubt that three species of elephants had lived in Malta.

Capt. Spratt said that it appeared to him that the chief interest of the communication lay in the greater comparative abundance of the larger species of elephant in the new locality.

North Staffordshire Naturalists' Field Club.—At a meeting of this Club, held at Leek, on the 24th February, Mr. W. Molyneux, F.G.S., read a paper on the Rhætic Beds of Needwood Forest. During an examination of the gravels which cover the high grounds on the margin of the Trent valley, west of Burton-on-Trent, Mr. Molyneux detected pebbles of sandstone and limestone, containing numerous fossils, which at first he could not identify. These were determined by Mr. C. Moore, F.G.S., and found to be peculiarly Rhætic in their character. Patches of Lias are laid down in two places on the Geological Survey map,—at Christchurch-on-Needwood and at Bagot's

Park,—and from these beds the author considered that his Rhætic pebbles were derived. They have been briefly noticed by Mr. H. H. Howell and the late Professor Jukes. Mr. Molyneux furnishes some notes on his examination of the beds *in situ*. The basement bed of the Rhætic deposits of Needwood consists of a white earthy limestone, from two to four inches in thickness, and containing at times sulphate of strontian. The junction of this bed with the Keuper marls may be seen in the marl quarries of Marchington Cliff on the east, and at several points on the west of Bagot's Park; also at the bottoms of the hills near Kingstanding and Horecross. It generally occurs nearly horizontally, as, in fact, do all the succeeding beds of the series. The best open section to be studied is at Butterwich Hill. The Christchurch section of Brakenhurst Hill is of an exceedingly interesting character. These sections show the first fossiliferous zone to consist of yellow sandstone, full of *Axinus cloacinus*. In the shales of the Brakenhurst Hill section Mr. Molyneux found casts of *Avicula* (?), and he has strong hopes of being able hereafter to add many forms to the list of its Rhætic fauna. It is curious that in none of these beds did the author meet with either limestones or sandstones of the same lithological composition as the pebbles found in the gravel, and he therefore infers that the beds to which they belonged have been carried away by denudation, and scattered in detached fragments far over the hill-tops to the east. The maximum thickness of these remaining Rhætic beds he estimates at 160 feet.—*The Burton Weekly News*, 18th March, 1870.

CORRESPONDENCE.

THE RAILWAY-CUTTING AT UPHILL, WESTON-SUPER-MARE.

Sir,—The section in the railway cutting near Uphill, to which Mr. Mackintosh directs attention in the last number of the Geological Magazine, has been noticed by many geologists.

The Lower Lias is shown resting abruptly against, and indeed dipping under the Carboniferous Limestone. This arrangement can in no way be referred to a buried sea-cliff; the Lias Limestones and Clays of the ordinary character are cut off sharply, and present none of the conglomeratic or shallow-water appearances that are usual at the margin of this deposit when reposing on the older rocks.

A fault is the only explanation of the phenomenon; indeed, no other suggested itself to my colleague, Mr. W. A. E. Ussher, or to myself, when we together visited the locality last summer. The hade of the fault, which is south, towards the Carboniferous Limestone, gives it the appearance of a "reversed" fault; but whether this is the real direction of the fault or merely a local irregularity in the hade of an ordinary fault, it is impossible to say. The upthrow of Carboniferous Limestone must have amounted to about 100 feet.

Other faults of little magnitude affect the beds to the north, where the Rhætic and New Red Marls appear in the cutting. The fault is, indeed, represented on the Geological Survey map, sheet 20, and it has long ago been pointed out by Mr. William Sanders, Dr. Wright, and others. HORACE B. WOODWARD.

8, CANONBURY LANE, N., *4th April.*

P.S.—Mr. Bristow, F.R.S., informs me that he has seen no reason to form any other opinion than the ordinarily accepted one, of a fault in this railway cutting, on the occasion of visits paid to it in 1867 and 1868.

IGNEOUS ROCKS OF CARBONIFEROUS AGE IN IRELAND.

SIR,—In the article "On the Basaltic Rocks of the Midland Coal-fields," by Mr. Samuel Allport, F.G.S., which appeared in your last number (p. 159), the author refers to the Scottish igneous rocks of Carboniferous age, but quite ignores those of the same period in Ireland, although descriptions of the latter were published long before those of Scotland. G. H. KINAHAN.

FOSSIL INSECTS IN THE BOURNEMOUTH LEAF-BED.

SIR,—The Rev. P. B. Brodie, in the March number of the GEOLOGICAL MAGAZINE, p. 141, directs the attention of the explorers of the Leaf-beds in the Lower Bagshot Series of Hants and Dorset, to the desirability of looking out for Insect-remains; particularly at Bournemouth. Mr. Brodie may be glad to learn that Mr. Wanklyn has already recorded the discovery of Insect-remains at Bournemouth, in the Annals and Mag. Nat. Hist. for January, 1869, 4th series, vol. iii. No. 13, p. 10. The specimen has been placed by the discoverer in the hands of Mr. W. S. Dallas, F.L.S., the Assistant Secretary of the Geological Society of London, who has kindly undertaken to examine and describe it.—J. F. WALKER.

MISCELLANEOUS.

THE GIGANTIC OOLITIC LIZARD (*Cetiosaurus*).—We called attention to the discovery of the thigh-bone of this great Lizard (GEOLOGICAL MAGAZINE for July, 1869, p. 336, Vol. VI.) in a quarry at Enslow Bridge, near Oxford. Prof. Phillips now announces[1] the discovery of further remains of *Cetiosaurus*. "The space of ground in which the bones are found (writes Prof. Phillips) is apparently quite limited. One may think the whole body of the vast old lizard, in the extremity of age, was here laid to uneasy rest; the parts separated by decay; the massive limbs disjointed, and the bones displaced. Imagine a surface of the ossiferous clay which covers the Oolite laid bare by the workmen. Look southward: before you are four bones laid rudely parallel, in a row, at intervals of 1, 2, or 3 feet. They are 64, 54, 45, and 37 inches long; 10 inches the least breadth in the narrowest part; 26 inches the greatest breadth in the widest part. These are bones of *Cetiosaurus*. Over them and in front of them, three days since, lay as many others, as large and as quietly reposing in their "longæval" graves; behind them, possibly, are still more bones, to be discovered at some future time. Bones of a much mightier area—probably hugest of all huge ilia—extended far and wide; vertebræ 8, 9, and 11 inches in diameter; monstrous ribs, of which the parts traceable and inferred are 59 inches long; all this within the compass of a few square yards. It seems like the burial-place of the great father of lizards, each of whose bones demanded—but only some could obtain—a separate grave."

[1] *Athenæum*, No. 2214, April 2nd.

Supplement to the Geological Magazine.

ON DEEP MINING, AND THE MINERAL-BEARING STRATA OF THE SOUTH-WEST OF IRELAND.[1]

By SAMUEL HYDE, Esq.

EEP mining has long been a problem in the southern part of
Ireland, and it is the object of this paper to endeavour to
w that up to the present time few attempts have been made
n a large scale, or according to any well developed and
ermined scheme to prosecute the research for minerals at depths
alling those in Cornwall and Devon. Why this region, and
up of rocks should have remained so long unexplored, possessing
it does such proof of valuable metalliferous veins, can only be
ounted for through the want of confidence and fixed determi-
ion to prosecute to great yet practicable depths, those indications
mally exhibited at the surface.

he south of Ireland, from Dungarvan and Youghal Harbours, on
east, to Cork, Dunmanway, and on to Dursey Head, west of
ntry Bay, on the west, is so important an area, in an economical
nt of view, that it deserves the attention of all who are interested
the wealth and prosperity of the southern parts of the Counties
Cork and Kerry, and of Ireland generally.

he country between Cork Harbour and Dunmanus Bay is almost
irely composed of the group of rocks termed Upper Devonian,
l Carboniferous slate, and more or less these rocks occupy
ches of country on to the Kenmare river on the west. The
called Carboniferous slate divides into a north and south
ge; the northern spur stretches into and occupies the north and
th sides of Dunmanus Bay, its southern branch terminating at
shbeg, near Skibbereen, forming the east headland of Roaring-
ter Bay. The point of bifurcation is at Carraghalicky lake. Thus
whole of the promontory from this point to Crook Haven and
zen head is composed of the deeper seated Devonian slates, etc.
ks equivalent in time, or of the same age and character as the

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[1] Read before the Geological Society of London, February 23rd, 1870.

well-known Killas of Cornwall. It is this strip of country, with its central ridge rising to 1,140 feet, (at Mount Gabriel 1,339), that chiefly claims our attention, as being perhaps one of the most important copper-bearing districts of the south of Ireland. Broad transverse valleys cut this ridge in two or three places, the chief and most important one being at Ballydehob, which gives rise to the waters which pass into Roaringwater Bay; others to the north and east, giving rise to the river Ilen, need not be mentioned; neither need we notice the parallel ridge to the north of the Mizen and Ballydehob range, and which separates Dunmanus Bay from Bantry Bay, although physically it is of high importance to the question at issue. This narrow ridge and promontory attains an elevation of 1,130 feet, several other points rising to 1,000 feet.

The strike of these two parallel ridges and the three parallel prolongations of the Carboniferous slate is about 25° north-east and south-west or east, 25° north and west, 25° south.

From Ballycummisk and Skull Harbour to Toormore Bay, and on to the Mizen Head, a smaller ridge of land runs parallel to the main axis, and it is in the east part of this range that the mines of Ballycummisk and Coosheen are situated.

The Devonian (Killas) or Old Red Sandstone, is without doubt the oldest formation throughout the south-west of Ireland, and, according to the maps of the Geological Survey of Ireland, and the Memoirs accompanying them, written by the officers of the Survey, it is divided into two groups (1) the "Old Red Sandstone" at the base, succeeded by (2) "the Upper Old Red Sandstone" (or Upper and Lower Old Red), the latter is about 800 feet thick, and near its lower boundary, according to the Geological Survey, occurs the "Copper Zone,"[1] and which would appear to "prevail throughout the whole of the south-west of Ireland."

The long peninsula of Glenarought and Slieve-Miskish, between Bantry Bay and Kenmare river, the axis of which is composed of Devonian Rocks, flanked by the Coomhola beds, contains the copper mines of Bearhaven or Allihies. These very productive mines are situated on low land, at the foot of the elevated Slieve-Miskish, which abruptly rises 1,240 feet above the western ocean. The western slope of this lofty and broken peninsula, and in which are situated the Bearhaven mines, is composed of highly cleaved slaty rocks or "Killas," interstratified with massive indurated and fine-grained sandy beds, also highly cleaved; the planes of cleavage being north and nearly vertical, and striking north 33°–35°; many varieties of the Killas, or clay slate occur, being grey, blue-grey, and buff in colour, the latter being most noted for the presence of copper.

The earliest known working in this Ballydonegan and Bearhaven area was commenced about thirty years since in an east and west vein or lode of quartz and copper pyrites, which was exposed in the cliffs north of Ballydonegan bay, termed the Allihies old lode, and which appears to have been worked some 50 or 60 fathoms deep. A

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[1] Mem. Geol. Survey. Explanations of sheets 200–2–3–4–5, etc., County Cork.

of greenstone (Diorite) runs north and south in the cliff to the
of this vein, and at right angles to the course of the lode.
her extensive mining operations succeeded and have been con-
d down to the present date under the name of the “Bearhaven
s,” and with varying results, and on the “*mountain and*
ches lodes,” levels have been driven deep. The Caminches
strikes north-north-west, with an underlie to the south-east; a
-course seems to have cut off this lode along its strike to the
h. In 1860 more than 1,000 hands were employed in the
haven and Allihies mines.

will be seen then that the mineral bearing rocks of the south-
of Ireland occur near or towards the upper part of the *lower*
sion of the Old Red Sandstone, or base of the Upper Old Red.
stones or calcareous bands occur throughout the whole series, and
e, when impregnated with, or containing copper, are locally called
een lodes.” It is believed that the thickness of the Old Red
lstone is between 2,000 and 3,000 feet, although the base
here appears to be exposed in this area; the upper 800 feet,
rding to the Geological Survey of Ireland, being called the
er Old Red Sandstone.[1]

series of anticlinal and synclinal curves occur in this region,
chief of which is that which traverses Ballydebob, Skull, Toor-
e Bay, and Crookhaven, &c. The axes of the Ballydebob
clinal strikes east 25° north, with a general dip to the north-
t of about 50°, and to the south-east 45°, and it is along this
the highest land occurs, being mainly composed of slates and
ty beds of the upper part of the lower Old Red Sandstone. South
his, between Cappagh Lodge and Skull Harbour, and close to
sbrin Cove, are situated the extensive and deep copper mines of
ycummisk, and on the east side of Skull Harbour occurs Coos-
mine, the geological position and mineral conditions of which
the subject of this communication.

he object of this notice is to bring before this Society and men
cience the main features of, and high importance attached to,
solution of the problem of deep and continuous mining opera-
s throughout the south and south-west of Ireland, and to
avour to parallel the mineral conditions of the south of Ireland
those of Cornwall, although it is well known that the granitic
other igneous rocks of the Cornish Promontory have not
determined south of Carlow and Waterford; except near
gerton, immediately south of Killarney, where the felspathic
nstones constitute very insignificant features in the physical
cture of the country.

Ve cannot but regard the south of Ireland as a continuous and
gral portion of the south-west of England, and south Wales, the
ations in rock masses being such as are due either to local
litions and causes at the time of deposition; or, probably still

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[1] Mem. Geol. Survey. Explanation to accompany sheets 200-3-4-5 of maps of the
gical Survey of Ireland, County Cork.

more, to metamorphic action, of the nature of which, at present, we know but little. But that the Lower, Middle, and Upper Devonian series of North Devon, and the corresponding groups of Cornwall and South Devon (under the name of Killas) are of the same age cannot be doubted. The relation of petrological or lithological conditions of the Devonian rocks of North Devon, with those of the South and South-western area of Ireland, is remarkable and almost complete. Equally so with the Devonian slates (Killas) and grits of north Cornwall, from Tintagel to Padstow, and the great Middle group, which occupies the country from Trevose Head to near St. Agnes Head; as well as the lower and great copper-bearing Killas of the South of Cornwall, from Truro to Mounts Bay. These groups of slaty and gritty rocks of the Devonian series in England are represented in Ireland. There are, nevertheless, local differences of high importance, doubtless due to the greatly developed intrusive masses of granite and greenstone, as well as the innumerable elvans which traverse the slaty rocks of Cornwall, and which have doubtless aided in the mineralization of the Cornish killas, imparting to it a character peculiar to itself. All lithological conditions, mineral evidence, and mining experience, tend to confirm the belief that the now two widely-separated metalliferous areas were once one continuous series. The English type having suffered the extremes of metamorphism, through deeply-seated igneous influence, and from other unknown causes, is more highly (so far as hitherto known) productive of mineral wealth.

It is not a little singular that Ballycummisk appears to be the only mine in which the copper lodes of the district have been deeply and fully developed, or where determined energy has been put forth to grapple with the difficulties of deep mining. No less than eight lodes have been ascertained to occur, and have been proved by the deep adit level driven from the sea at Rossbrin cove, the whole hade, dip, or underlay south 85°, or about 1 in 12. Four of these lodes are well defined, and are worked at Ballycummisk, viz.:

Pope's Lode;
The Lady's Vein;
Big Vein—the old Baryta Vein; and
North Lode.

Each lode is characterized by particular features, the copper being gray, purple, or yellow in one, yellow in another, micaceous iron, quartz, baryta, and yellow copper in the third, and carbonate of lime, peach, purple, copper ore, etc., etc., in the fourth. The remaining lodes in the sett are as yet unexplored. All the lodes are parallel, and run east and west, deviating about 32° north of east and south of west.

A well defined elvan course traverses the sett nearly east and west, and nearly parallel to the No. 1 lode. To the north, and bearing north-east and south-west, occurs the large fault or flucan course, which deviates about 17° from the strike or bearing of the lodes, and crosses all the veins except No. 1. This flucan, like the lodes, underlays south, and materially influences the production of mineral at its junction with the lodes.

The district around Ballycummisk and the mine itself may be said to be the only place where a thorough investigation has been made so as to determine the nature of the rocks, and the quantity and nature of the copper ores; and the prosecution of this question to its utmost will doubtless materially alter the general belief that *minerals of value are not to be worked* at great depths in the south of Ireland. This belief has been, and is now, held by many, and the Memoirs of the Geological Survey, and especially the peculiar views of the late Professor Jukes, have tended strongly to mislead and deter either landowners or those possessing local interest from investigation.

In the Memoirs of the Geological Survey, explanation to sheets 200-3-4-5 etc., p. 27, in a " note on the mines of the south-west of Cork," Professor Jukes, in mentioning the examination made by the Survey over that district during the years 1853–6 (fifteen to seventeen years since,) is under the impression that the ores of copper were deposited mechanically, so that " *all the grits and slates* were, or are, here and there impregnated with copper ore, over all the district stretching from Waterford through Cork into Kerry." "This copper deposit was, like most materials deposited from water, not a continuous sheet, but occurring in patches in different beds of grit or slate through a thickness of 300 or 400 feet over all that area; ' the copper ore was distributed here and there among these beds as a copper sand, or copper mud, mixed with the siliceous and argillaceous sands and clays.' " Professor Jukes proceeded to state that " eventually these beds were greatly indurated—greatly disturbed and tilted up into highly inclined, often vertical or even inverted positions, and bent into numerous folds."

These remarks apply to the deposition of the beds of grit and slate that occur somewhat near the top of the lower division of the Old Red Sandstone; the lower portion of the yellow or upper Old Red Sandstone of the south-west of Ireland, the " Copper Zone" of the Geological Survey. Whatever may have been the particular mode of original deposition, whether derived and deposited under aqueous conditions or influence, so as to have impregnated *the then mud and sands, &c.*, but now slates and grit rock, with copper, it in no way agrees with the concluding deductions drawn by Professor Jukes.

Professor Jukes states his belief that the disturbances which followed " must have been accompanied by many fractures, causing fissures, some of which would remain more or less open below in different parts of their course." He then goes on to say that "some action subsequently determined the *segregation* of some of the copper ore out of the beds into some of these hollow fissures, by some process, of the exact nature of which we are ignorant, and thus new ' mineral veins' or true lodes were formed here and there about the country."

Now the great object of this communication is to show that, whatever theories or hypotheses may be advanced to account for the origin of the ores or conditions of some lodes, there is evidence to show and prove that down to the depth of 1,200 feet, or 200 fathoms, copper ores of high value and rich percentage are being extracted, and that from lodes as well defined, characteristic and typical, as any occurring in rocks of the same age and character in Cornwall; and it is confidently believed that over the peninsulas of Skull, Kilcrohane, and Kilnamanagh, &c., west of Roaring Water Bay, most extensive and deep copper mines will yet be successfully developed; and all analogy with other localities and physical conditions of the district point unmistakably to this, if prosecuted upon scientific principles with energy and determination.

At the time Professor Jukes wrote (1861?) he states that "with the exception of the Allihies (Bearhaven) mines, none of the lodes (whether true or false) of the south-west part of the County Cork have yet been proved to have a sufficient quantity of ore in any one locality to make a rich mine." Whatever may have been the author's opinion and views in the year 1861, derived from an examination of the county in the years 1853-6, it is now incontestably shown and proved that Ballycummisk and the Bearhaven mines, etc., have fully established the fact that profitable deep-mining in south-west Ireland is no longer a matter of doubt. The Allihies mine is 220 fathoms or 1320 feet deep, and Ballycummisk 200 fathoms or 1,200 feet deep, both making large returns of ore; the 198-fathom level at the latter mine being now extremely rich in yellow and peacock copper ore, and the enclosing matrix cannot be distinguished from the killas of Cornwall and Devon.[1]

Again, it may be mentioned, that ores of many other economic minerals have been worked in this area, giving conclusive grounds for well-assured hope that through vigorous research much is yet to be done in the south of Ireland; and it by no means follows that if in some Irish localities the ores of copper, lead, or iron appear abnormal in condition, as compared with other localities, that there are not, nevertheless, characteristic and normal lodes (now well determined) along given and clearly understood lines of country.

It is well known that the ores of copper in the south of Ireland frequently occur in beds strongly impregnating the killas, &c., in which they appear, in some cases as grey copper; but, under meteoric metamorphoses when near the surface, become converted into malachite or green carbonate, or, under other changes, into the blue variety —blue carbonate (Azurite)—but their chief value is under the form of the yellow and peacock copper pyrites, as occurring in well-defined and regular lodes and veins. Not only is the *metalliferous* system of veins well developed in the south-west of Ireland, but also the quartz and lime veins, thus evidencing conditions similar to those of other mining areas where faults and fissures, etc., occur, and have been filled in subsequently to their occurrence. In the south of Ireland, as elsewhere, the oblique running veins (with relation to the strike of the strata or beds) usually make ore or are mineralized. Again, contra lodes or fissures which occur in the cupriferous grits or slates (killas), and which themselves contain much disseminated copper (especially the green carbonate), usually contain good ore, or become good lodes. This, under the influence of time, segregation, and other agencies, we should expect, and it is one of the main features to be sought for in the copper-bearing region of the south-west of Ireland; especially if the veins dip at a greater angle than the beds, though running with the strike; and it is found, in either case, in the south of Ireland, that the lodes or veins take up ore from the beds through which or across which they or the fissures pass. They may be very productive or the reverse, trial only solving the question; and so long as the sides or walls of the fault or vein are not permanently squeezed together, there is room for belief that at different levels or depths the veins will vary in width and richness, as in other districts.

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[1] It may be mentioned that the so-called No. 2 Big-ben, at the 198-fathom level, is about 15 feet in width, and is extremely rich in the ores of copper at this depth; the specimens exhibited on the table were recently taken from that level, and there is nothing in the aspect of the lode, either in its course or depth, to show diminution of produce or yield. It may not be out of place here to state also that the Bearhaven mines are said to have returned upwards of £2,000,000 sterling since commencing operations; Ballycummisk, situated in the area under description, £50,000; and Coosheen £22,000, the latter from operations above the adit.

We must doubtless guard against confounding the so-called elvans of the south-west of Ireland with those of Cornwall and other localities—the term being used in a vague and uncertain sense in the former locality—whereas the elvans of Cornwall, which are of undoubtedly igneous origin, and associated with the felspathic and porphyritic rocks, occur as true dykes, traversing the killas in many directions and apparently almost without law. Certain light green coarse sandstone, or grit bands, occurring with and differing from the associated killas, are termed elvan in the south-west of Ireland, and are regarded by the miners as being favourable for the production and goodness of copper, especially if associated with the paler-coloured greenish slates. We may draw another parallel with the true mining area of Cornwall, so far as concerns the law of the relation of the elvan courses to the lodes, or veins of copper in the south of Ireland. In Cornwall the same coincidences are observed between the lodes of copper and elvan, for in both areas they usually run nearly parallel to each other, or deviate only by some small angle. This is notably the case at Ballycummisk, the *elvan* (whatever be its nature, though doubtful if a true elvan) running parallel to load No. 1 through the entire sett, but crossing it to the east. We cannot, however, insist upon too close a parallel on this point between the peninsula of the two islands, arising from the fact that in the south-west of Ireland there are no known masses of granitic or igneous rocks associated with the slates and grits, and which, in the mineral districts of Cornwall. have played so important a part in the impregnation of metalliferous veins, etc. Again, we have not any true standard or evidence to show the cause or the *period* when the Devonian rocks of the south-west of Ireland became contorted and broken, there being no overlying or newer rocks to give date, and no known deeper seated igneous rocks, through whose agency the mass of killas may have been influenced, metamorphosed, and mineralized.

We cannot agree with Professor Jukes (*loc. cit.* p. 28), who believes that the "wide diffusion of copper ore in small quantities over so large an area is against rather than in favour of the probability of rich mines being found." This really has no bearing upon the question of "lode or vein" deposits and deep mining, to be clearly distinguished from that of copper occurring in beds of sandstone or shale, mechanically distributed through their mass. We believe these mechanically deposited or amorphously distributed cupriferous masses in the beds of killas and sandstone, to be the source, through time and segregation, of the rich copper ore in the lodes and veins now traversing the highly inclined and contorted beds in which they occur—whether, as Professor Jukes supposes, the copper was derived from the "waste and destruction of some original mineral vein district," and does not form here an original mineral vein district itself, is a question which presupposes the existence of older metalliferous rocks and lodes over the area (but now no longer recognised), or rocks, the waste and result of which is the present Old Red Sandstone of the south-west of Ireland.

West of Ballycummisk, and immediately east of Skull Harbour, is situated Coosheen mine, where there appear to be no less than eleven lodes, which some years since were proved and worked upon. All these are east and west lodes, varying in their bearing or direction from 10° east to 25° north. Seven of the eleven are copper-bearing, containing either yellow, purple, and gray ore, or green carbonate, and underlay or dip south. The sett is traversed from north to south by a cross course or fault, accompanied by a parallel and well-determined flucan, which seems to have shifted the lodes. The Killas to the south of the Coosheen dips north 40° to 60°, implying that the mine is situated in a synclinal axis, parallel to the Ballydehob anticlinal, and may be the north dip to the north-west face of the anticlinal, which runs south of Ballycummisk mine and through Rossbrin cove. No less than five faults traverse the copper-bearing zone of the Upper Old Red Sandstone, between Cappagh mine on the east, and Skull Harbour on the west, and the lodes of Ballycummisk and Coosheen are all more or less affected by them.

It may be important to state that, at 42 fathoms from the surface, and 16 fathoms below the deep adit, the No. 6 or old lode dipped south 6° in 1 (or 80°), and contained a leader of 7 inches of solid gray copper—the remaining 6 feet of the lode being composed of "quartz gray copper, green carbonate, and blue peach." Even at the limited depth or shallow working mentioned, upwards of £20,000 worth of copper ore has been returned. It is believed, from the nature of the lodes, that Coosheen will be carried down to depths equal to that of Ballycummisk, for it cannot be doubted but the lodes of both setts are the same, and all are more or less parallel to the strike of the Upper Old Red beds; and such appears to be the law as regards the position and run of the lodes in the south-west of Ireland.

The correlation of the rock masses of the south of Ireland, especially those of Kerry and south-west Cork, have been a difficulty with many distinguished geologists; and the relation they hold to the so-called Devonian series of north Devon and Cornwall is even now a disputed question with many.

It is therefore very important to understand the relation of the two mining areas, which occupy a similar geographical position in both promontories, viz., that of south-west Ireland and south-west England. It is true the succession of the Palæozoic series is clearer and better developed in the south-east, south-west, and central Ireland, than in Cornwall; the Old Red Sandstone of Ireland being known to repose upon the Upper Silurian series of the Dingle promontory, and upon the Lower Silurian in Waterford.

In Cornwall and Devon, on the contrary, no Upper Silurian rocks of either of its sub-divisions are known; and the Old Red Sandstone, or Devonian series of the English peninsula, have no known base, such having never been determined in its typical areas, viz., north and south Devon and north Cornwall. This problem has yet to be solved, and the determination of Upper Silurian rocks, *south* of Pembrokeshire, holding some relation to the Linton and Ilfracombe series in north Devon, or to the same series that constitute the structure of the west coast of Cornwall, from St. Agnes Head to Tintagel and Boscastle, would perhaps decide their relation to the Devonian rocks of Kerry and south-west Cork.

It is true we have at Bolt Head and Start Point, in the south of Devon, a series of Crystalline Quartzite rocks, believed to be of Silurian age, and some equivalent beds at Mevagissy and the Dodman, in east Cornwall, but whether they are equivalents of the Cambro-Silurian series (Caradoc and Llandeilo) of east and central Ireland is doubtful. Whatever may be the age of the Start and Dodman rocks, they are the only representatives of the Silurian series in Devon and Cornwall, being mere remnants of a once largely spread group to the south, originally connecting the Palæozoic rocks of Brittany, or north-west France, with south-west England.

The details of the Devonian system in the two countries seem to involve rather a question of terms, than difference as to age; though in an economical, mineral, or mining point of view, it is extremely desirable that the relationship of the group of rocks occupying the two areas should be cleared up. If this cannot be done stratigraphically, it is hoped some light may be thrown upon the question by deep-mining in Ireland, and a knowledge of the deeper physical aspect and structure of the Irish rocks arrived at by comparison with those of the Cornish area. Also, the intimate structure and 'conditions of the lodes and their contents, such as the mode of infilling and arrangement of their mineral contents, systems of underlay, directions or bearing, etc., nature of the cross courses and true relation of the Irish Elvans to their own rocks and minerals, as well as to those of Cornwall, at present very little understood.

We are aware that the great masses of igneous rocks which have defined details of certain mines; and when we remember that above forty are named as occurring in the county Cork alone, and most of these copper, it is evident that, with a thoroughly organized system of mining, based upon known local laws and conditions, and with capital properly employed, the south-west of Ireland should take a prominent place in the history and practice of mining.

A very able though short notice of the Bearhaven or Allihies mines occurs in the under-mentioned memoirs:—"Explanation to sheets 197-198, and the south-east part of No. 101. Counties Cork and Kerry, 1860, by W. W. Smyth, M.A. F.R.S." The author here specially names the depths, yield, and all the main features of these mines, and clearly indicates, associated with the recent energetic work at Ballycummisk, that much is to be expected from the united forces of energy, ability, and capital; as applied to deep-mining in the south-west of Ireland.

THE

GEOLOGICAL MAGAZINE.

No. LXXII.—JUNE, 1870.

ORIGINAL ARTICLES.

I.—On the Occurrence of Elephant-remains in Ireland.

By Professor Robert Harkness, F.R.S., F.G.S.[1]

THE earliest discovery of Elephant-remains in the British Isles appears to have been made in Ireland, and is recorded in the xxixth volume of the Philosophical Transactions.

This discovery was made about the year 1715, "in digging the foundation of a mill, near the side of a small brook that parts the counties of Cavan and Monaghan," at Maghery, eight miles from Belturbat. Here four molar-teeth of an elephant were found, two of which were of a large and two of a small size. A portion of a lower jaw, containing one of these teeth, was also met with; likewise a part of the skull, which fell to pieces on exposure to the atmosphere; and some other bones of the skeleton.

The account of the discovery of these bones is given by Mr. Francis Neville, who states that they were found at the depth of about four feet from the surface of the ground, and their mode of occurrence is described as follows :—"The bed on which it lay (referring to the locality) had been laid with ferns,—with that sort of rushes here called sprits,—and with bushes intermixed, and nut-shells. Under this was a stiff, blue clay, in which the teeth and bones were found; above this was, first, a mixture of yellow clay, and sand much of the same colour; under that, a fine white sandy clay, which was next the bed; the bed was for the most part a foot thick, and in some places thicker, with moisture clean through it; it lay close, and cut like turf, and would divide into flakes, thicker or thinner at pleasure; and in every layer the seed of rushes was as fresh as if new pulled, so that it was in height of seed-time that these bones were laid there. The branches of the fern, in every layer as we opened them, were very distinguishable, as were the seeds of the rushes and the tops of boughs. The whole matter smelt very sour as it was dug; and tracing it I found it 34 feet long, and about 20 or 22 feet broad."

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[1] In the exploration of the ossiferous breccia, referred to in this communication, the author received great assistance from Dr. A. Leith Adams, F.L.S., F.G.S., 22nd Regt., to whom geologists are so much indebted for the knowledge they possess of the fauna of the caves of Malta. It was owing to his labours that the additional remains of Elephants and other animals were obtained from the Shandon breccia.

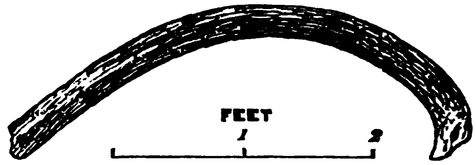
This description of the circumstances under which these Elephant-bones and teeth were found at Maghery leads to the inference that an old and small lacustrine deposit was the source from whence they were obtained.

Concerning the teeth it is stated that "the two large ones are of equal weight, $2\frac{3}{4}$ lbs. each; the two small teeth are 6 ounces each; but some of them are wasted, and some roots that enter the jaw are broken off."

These teeth are described by Dr. Thomas Molyneux, who regarded them as "the four grinding teeth in the lower jaw of an elephant," and he enters into a somewhat detailed description concerning them. They are figured, and contrasted with the grinding surfaces of molars of the African elephant in the volume of the Phil. Trans. above alluded to.

The figures of these teeth from Maghery appear to represent a form of enamel plate, which is more nearly allied to *Elephas antiquus* than to *E. primigenius*, the greatest breadth being in the middle, and possessing the somewhat lozenge-shaped outline which is characteristic of *E. antiquus*.

There is another reference to the discovery of Elephant-remains in Ireland.[1] It is stated that "some years ago was dug up, within a mile of Whitechurch, the rib of an elephant, which was no doubt such (*vide* Plate the last, fig. 2), it agreeing with the description of that animal in De Moulins and Blair." A sketch of this rib taken from the plate referred to is here annexed.



Supposed rib of Elephant.

The rib above alluded to is regarded as belonging to a whale by Dr. Oldham,[2] and it certainly possesses much of a Cetacean aspect. The locality, Whitechurch, mentioned by Smith as affording this bone, is about six miles west of Dungarvan. From some information which we recently obtained it would appear that, about fifteen years ago, a considerable quantity of large bones were discovered in a cave near Whitechurch. These were said to consist of leg bones, which were described to us as being almost as thick as a man's body; also teeth, said to be six times larger than those of a horse; and a skull was mentioned, which was represented as having "four horns projecting from it." Most of these bones were probably those of elephants; and the skull with the four horns that of a reindeer, with portions of the brow antlers and the main shaft preserved.

The discovery of these bones recently at Whitechurch would tend to render it probable that the rib alluded to by Smith was that of an elephant, notwithstanding the Cetacean-like outline as figured in the plate before alluded to. Unfortunately, these bones have all disappeared, some of them having been carried away by rag-and-bone collectors.

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[1] Smith's Ancient and Present State of the County and City of Waterford, MDCCXLVI., page 81.

[2] Journal of the Dublin Geol. Soc., vol. iii., page 70.

The next discovery of Elephant-remains in Ireland was made in 1859. This was also in the county of Waterford, in the neighbourhood of Dungarvan.[1]

The locality which afforded these remains is a place called Shandon, about half-a-mile north-west of Dungarvan. They were discovered in working a limestone quarry for road material. Mr. Brenan, who is resident in Dungarvan, first brought these remains under the notice of naturalists, his attention having been directed to them in consequence of "a workman exhibiting a large bone as that of an antediluvian giant in the town of Dungarvan.

Many bones were obtained from Shandon by Mr. Brenan, and are now in the Museum of the Royal Dublin Society; a few are, however, in his possesion still. The bones in the Museum of the Royal Dublin Society have been recognized by Dr. Alex. Carte, as appertaining to the "mammoth, cave-bear, brown bear, reindeer, horse, and hare, with a small portion of the humerus of a bird, as yet undetermined."

With reference to the circumstances under which the bones of the mammals at Shandon occur, it would seem, at first sight, that they had been derived from an ordinary ossiferous cave, but this, however, is not absolutely correct. On visiting the spot we were informed by a workman, who had wrought in the limestone quarry from whence these remains were obtained, that the bones occurred in the solid rock. The quarry has for some years been abandoned, and we were told that there was no chance of finding any more specimens.

On carefully looking along the surface of an exposed mass of breccia, forming a portion of the face of the old quarry, fragments of bone were recognizable in it; and further investigation proved that bones, and portions of bone, are still to be met with in considerable abundance in the breccia, about the horizon where they can be seen on the face of the quarry.

The Carboniferous Limestone of the old quarry at Shandon dips towards the south-west, at an angle of about 10°, and no boulder-clay is seen upon the surface of the limestones, which here overlays the bone bearing breccia. The face of the quarry at the spot where bones are seen in the breccia has the following arrangement from above downwards:—First, about 18 feet of regular limestone, intersected by a great number of closely approximating joints, which afford easy access for the surface water into the lower portions of the rock, is seen. Beneath this mass of regular limestone, breccias occur, irregular in thickness, but averaging about five feet, above which are open spaces separating the breccias from the superior limestone. These breccias have resulted from the falling down of masses of limestone rock into hollows which had been formed by the agency of water. In some cases these breccias lie upon a limestone floor; in other instances the fragments have wedged themselves together before reaching the floor. In some spots some of the fragments have fallen upon the floor, but others, which have subsequently become detached from the roof, did not reach this position, but have become jammed together, and form the roof of caves. This was the case at the spot where the osseous fragments were found, for, on clearing away some rubbish which had been here accumulated, a cave, about two feet high, was found, having a brecciated roof about five feet in thickness. This brecciated roof was cemented together by stalagmitic matter.

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[1] Journal of the Royal Dublin Society, vol. ii.

The floor of this cave was in part also a breccia, united together by crystalline carbonate of lime. This latter was much more abundant in the floor than in the roof; and the angular fragments which it cemented together were not usually found in contact with each other. It was in this lower breccia and stalagmite that the bones were found.

At this spot the layer of breccia and stalagmite was about two feet in depth; but its thickness is extremely irregular, as near the western side of the opening of the cave it is not more than six inches in depth, and in some spots it dissappears altogether. The bones occur in the upper part of this layer, forming the floor of the cave, rarely at a greater depth than four inches, and sometimes they are even nearer the surface of the floor. This stalagmitic breccia rests upon a mass of solid stalagmite, which is here about eighteen inches thick; and beneath this stalagmite another cave is seen. This cave, was, however, so blocked up by masses of rock that an entrance could not be made into it with the means which we had at our disposal.

The stalagmitic breccia which yielded the bones was difficult to work. This, however, resulted from the confined space which was available for working in rather than the hardness of the rock itself.

That bones occur in it abundantly is shown by the circumstance that, in an area of little more than a square yard, we obtained from it five Elephant's vertebræ, one of which retained its spinous and transverse processes nearly perfect. Portions of five Elephants ribs were also found. Besides these, fragments of the metacarpal and metatarsal bones of the reindeer were also met with; and a small fragment of a rib apparently belonging to the same animal. In some instances these bones were imbedded solely in the stalagmite, but more frequently a thin layer of fine clay separated them from the enveloping hard matrix.

The bones occurring in the stalagmitic breccia are in a more or less broken condition; the fractures, however, seem all to have been made since the bones were brought into the cavern. The surfaces of the fractures are generally very sharp, and the broken pieces are frequently in juxtaposition. In the case of the metacarpal and metatarsal bones of the reindeer, before referred to, these afford some interesting evidence as to the cause which has produced the fractures in these bones. The fragments possess all the features of such bones as are now regarded as having been split by man for the purpose of obtaining the marrow which they afford.

The cause of the fracture of the bones which are found in the stalagmitic breccia at Shandon has been the falling of fragments of limestone from the roof of the cave while the bones lay exposed on the surface of the floor; and subsequently the infiltration of carbonate of lime has consolidated the fallen fragments into the hard breccia in which the animal remains are imbedded.

As concerns the occurrence of mammalian remains in the breccia of Shandon, there are some circumstances in connection with this which lead to the conclusion that neither the transporting agency of water, nor the influence of carnivora, had anything to do with their appearance here. The bones have no traces upon them of the action of such a force as running water, the only evidence of such a force being in the occurrence of the thin film of clay which, in some cases, invests the bones, and this clay has emanated from water from above percolating through the joints of the rock. There is no trace of anything in the form of a rolled pebble in the breccia, the limestone fragments being as sharply angular as when first detached from their parent rock.

With reference to the influence of carnivora the conditions of the bones indicate that such animals had not used the caves as dens. The more cellular portions of the skeleton are as intact as any other part; and there is nothing to show that the bones were broken in such a manner as they exhibit when they are found associated with the remains of the hyæna.

The only carnivora of which the bones are mentioned by Dr. Carte as occurring in the Shandon breccia are the cave-bear and the brown bear, the former being most probably only a very large variety of the latter, a relationship similar to that which the ancient cave-lion had to his modern African representative. Besides these remains of carnivora, alluded to by Dr. Carte, it would appear that the wolf was also a contemporary with the mammoth in Ireland, as Mr. Brenan has in his possession a portion of a large lower jaw of this animal, which was obtained from the Shandon breccia.

The late Dr. Falconer mentions the occurrence of the remains of the wolf with those of the mammoth in connection with the caves of the Gower peninsula. One of these caves, Spritsail Tor, besides yielding the remains of these animals, afforded evidence of a much more extensive fauna than the Shandon breccia. In the case, however, of Spritsail Tor Cave, this seems to have been a hyæna's den, as coprolites of this animal occur in it, and also gnawed bones of *Bos Equus* and *Cervus*.[1]

Ireland has hitherto afforded no traces of either the hyæna or the lion. The Pleistocene carnivora of this country were confined to the bear; of which there are, however, no historical records; and the wolf, which was finally extirpated about the year 1710.[1] These two animals seem to have had very little influence in the dragging of the bodies of other mammals into caves; and although we have their bones associated with those of herbivora in the Shandon breccia, this association must be looked upon as resulting from other causes than the predatory habits of the bear or wolf.[1]

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[1] Quart. Journ. Geol. Soc., vol. xvi., page 491.

[1] Smith's History of the County of Kerry, page 173.

The occurrence of several vertebræ and ribs of the mammoth in an exceedingly small area in the Shandon breccia, a space little more than a square yard, and also the unworn and ungnawed condition of these bones, lead to the inference that the whole skeleton of a mammoth had been embedded in this substance. Four of the vertebræ were portions of the continuous series of the spinal column; and had circumstances permitted further explorations in the breccia, other bones of this skeleton would doubtless have been discovered.

The body of the animal to which these bones appertained must either have been transported here, or the creature must have died on the spot where its bones occur. With reference to the former case, the agency of water only could have effected this, but every circumstance in connection with these bones is antagonistic to the idea of such a mode of transport. Nothing remains, therefore, but to accept the conclusion that the animal died on the spot where its bones are found. The features which are seen in connection with the limestone of Shandon lend support to the conclusion that mammoths died here. During the time when the breccias were being formed, the limestone exhibited projecting ledges of rock, having beneath them open spaces which would afford shelter for mammoths and other animals; and many wild creatures, at the present time, when they find death approaching, seek for shelters of this kind. Subsequently these rock-shelters of Shandon have undergone great changes, in consequence of the falling of overhanging masses, fragments of which accumulating above the skeletons, enveloped them in the hard substance from whence the bones are now obtained.

II.—ON SOME NEW AND REMARKABLE ECHINODERMS FROM THE BRITISH PALÆOZOIC ROCKS.[2]

By Professor de KONINCK, M.D., For. Mem. Geol. Soc. Lond.

(PLATE VII.)

DURING one of my last visits to England I had the opportunity of visiting a great number of palæontological collections. Amongst those which afforded me the greatest pleasure, I would specially mention the collections of Mr. Edward Wood, F.G.S., at Richmond, in Yorkshire, and of Mr. John Gray, at Hagley, near Stourbridge.[3]

These gentlemen, who honour me with their friendship, and who gave me the most hospitable reception that one can possibly wish for,

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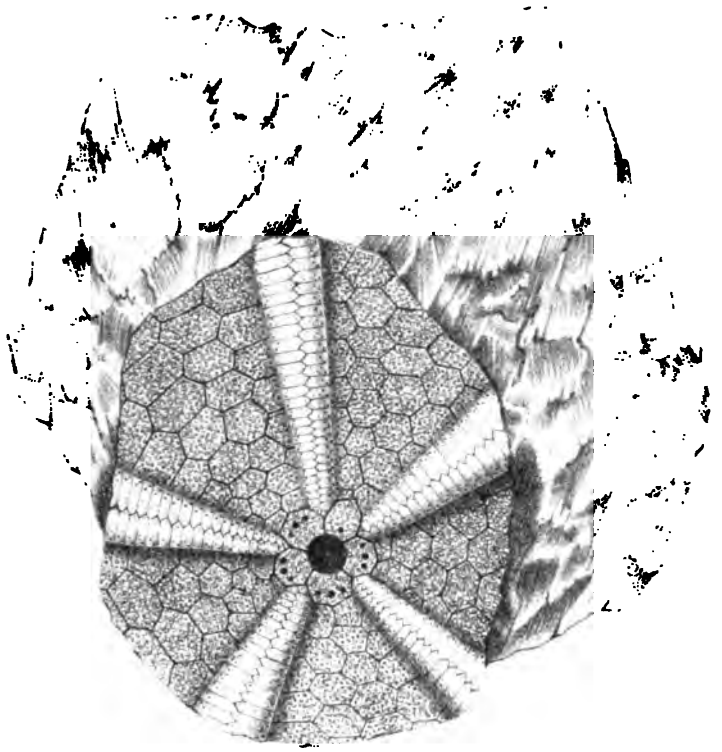
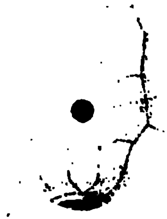
[1] The abundance of the remains of the *Megaceros Hibernicus* in Ireland may probably be attributed to the absence of the hyæna and the lion from the Pleistocene fauna of this country; and also to the early separation of the country from Great Britain.

[2] Translated from the Bulletin de la Academie Royal, Bruxelles, 2nd series, tome xxviii., pp. 57-65. Planche. 1869.

[3] Mr. John Gray's very choice collection of Upper Silurian fossils has since been acquired for the British Museum.





British

both possess palæontological collections such as are very seldom met with amongst private individuals. The museum of Mr. Edward Wood rivals many public collections. It contains one of the most complete series of British Carboniferous fossils known, and more especially a magnificent suite of specimens of the several species of *Woodocrinus*—a genus formed by me, and to which I have already had the honour of calling the attention of the Academy.[1]

Mr. John Gray, who resides at Hagley, not far from Dudley, possesses an admirable collection of Silurian fossils from that locality, developed and classified with extreme care.

It is in the first of these two scientific depositories that I met with the specimen of *Palæchinus*, of which I here give a figure of the natural size, as drawn by me on the spot, with all possible care and correctness.

This specimen is remarkable on account of the presence of the apical plates, which are well preserved, and which have not yet been seen in any other specimen of the same genus. Though it has been compressed from top to bottom, the anal aperture remains perfectly intact. It is easy to see that it is limited by one of the borders of each of the five genital plates that surround it. Of these plates, four are identical: the form is heptagonal; they are broader than long; each of them is perforated by three rounded and well-marked pores, placed in a line near the inferior border of the plate, and parallel to the border on every side. Each of these plates forms the summit of one of the sides of the test.

The fifth plate (corresponding to the irregular side) is also heptangular in outline, but differs in form from the other four, being longer than broad, and having only a single pore, placed on the median line of the plate, near the border of the anal aperture; that is to say, in a situation opposite to that occupied by the pores in the other plates, as can readily be seen by referring to Fig. 1 in Plate VII.

The specimens I have examined do not show any trace of ocellar plates.

I had long since observed genital plates, perfectly identical to those I have just described, among the fossil *débris* from the Carboniferous Limestone of the environs of Tournay; but, as I always found them isolated, it was impossible to determine their real place and precise signification. There cannot be any longer the slightest uncertainty as to their nature. The specimen in Mr. Wood's collection, and also the detached plates found at Tournay, seem to belong to *Palæchinus sphæricus* of Scouler.[2] Mr. Wood's example comes from the Carboniferous Limestone of Kirkby-Stephen, in Westmoreland, where fragments of *Palæchinus* are not uncommonly met with.

If there still remained any doubt as to the presence of Echinodermata in the palæozoic strata, my observations would tend to remove them completely. I should, however, observe that the genital plates of *Palæchinus* differ essentially from those of all the Echinodermata belonging to the more recent geological period, by the presence of three well-marked pores on four of them, whilst the fifth is usually perforated by only one aperture.

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[1] Bulletins Acad. Royal Bruxelles, 1854; Geologist, vol. i., 1858, p. 12, plates i. and ii.; GEOLOGICAL MAGAZINE, vol. ii., 1865, p. 163, plate v.

[2] M'Coy's "Synopsis of the Carboniferous Fossils of Ireland," p. 172, pl. xxiv., fig. 5.

I shall avail myself of this occasion to rectify a determination that I made in 1844. In my work on the Carboniferous fossils of Belgium, I have described and figured, under the name of *Cidaris Münsterianus*, a few plates and radioles of a species of *Echinus* that I discovered at Visé, and which M. Desor referred in 1858 to his genus *Eocidaris*,[1] but which in reality appertains to the genus *Lepidocentrus*, created by Müller in 1856, upon a species very nearly related to mine that he had discovered in the Eifel, and of which he has obtained a fairly complete specimen. The Carboniferous species must, then, be placed under the genus *Lepidocentrus Münsterianus*. It shows, at the same time, that the species of that genus are not exclusively Devonian, as it was formerly supposed.[2]

The second form to which I would draw attention is a fossil of most peculiar structure, which I had the opportunity to study in Mr. John Gray's collection. It belongs to the family of the *Cystideæ*, of which it constitutes one of the most extraordinary types; and, from its very peculiar form, it cannot be referred to any known genus of that large family. I am obliged to form a new genus—*Placocystites*—for its reception. The essential characters are as follows:—Calyx of a compressed form, concave on one side and convex on the other, composed of four or five series of plates, symmetrically disposed on the sides of the vertical axis, in the line of which is placed the anal aperture, formed by semicircular hollows on the borders of two symmetrical plates placed in juxtaposition above the ovarian plate; peduncle with an oval suture. I have named the only species of this genus known to me, *Placocystites Forbesianus*, de Kon.

Mr. J. Gray possesses two specimens of this genus;[3] that which I have drawn is the more complete and the best preserved. Both are from the Wenlock Limestone of Dudley, a member of the Upper Silurian series of Sir Roderick I. Murchison. This species, of middle size, is formed of a base, which seemed to me to be composed of one single plate. On the anterior side are seen nineteen small polygonal plates, not including the base. The two lateral parts are perfectly symmetrical. The base supports a horizontal series of five plates, of which the hexagonal median one is longer than broad, and bears, a little to the left of its centre, a small aperture or ovarial impression, of a circular and well-marked form. The two lateral plates which join these directly are about of equal length, whilst the other two, further from the centre, are wider and longer, each of these last surmounted directly by two others, of which one is very long, and is followed by a shorter one.

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[1] P. 35, pl. E, fig. 2, *a*, *b*, *c*, *d*.

[2] Synopsis des E'chinides fossiles, p. 156.

[3] Now in the British Museum.

These three plates, united, form on each side of the fossil a radius similar to that of the Crinoids proper. The second range is composed of four plates, united symmetrically in pairs, and alternating with the plates beneath. In this way the suture becomes median, and it is on this suture, and towards the middle of the two centre plates, that the anal aperture is seen; it is circular and about three millimetres in diameter. The series which follows that enclosing the anal plate is only composed of three pieces, a little longer than broad, alternating with those which serve as their supports, whilst the last range, also composed of three small plates, is placed immediately upon the preceding. All these plates are perfectly smooth on their external surface.[1]

The posterior side is concave over its whole extent, except near the base, where a subconic median lobe projects, as is shown in Figs. 3 and 4, Pl. VII., which accompanies this paper. It results from this arrangement that the two sides of the test are very much compressed together, and leave but a small space for the soft parts of the animal.

In spite of the attention with which I examined the specimen figured, which was the only one on which the posterior surface was visible, I was unable to discover any division into plates on that side. It would indeed be surprising, however, if it were composed of only one piece.[2] I am driven to believe that this appearance is only due to the state of fossilization, by which all traces of separate plates have vanished. I shall make the same observation concerning the base. It is furnished with a slight oval depression, limited by a narrow border, which leads one to suppose that the animal has been supported by a stalk. Seen from beneath the base it presents the form of a crescent, see Plate VII., Fig, 4. I have dedicated this species to my friend, the late lamented Professor Edward Forbes.

I shall conclude this paper by the description of a new species of *Haplocrinus*, which I propose to call *H. granatum*.

This genus was created by Steininger in 1834, for a small species of Crinoid common in the Eifel, but which Goldfuss had already described under the name *Engeniocrinites mespiliformis*.[3] Until now, this last species, and that described by Prof. James Hall, under the name of *H. Clio*, had remained the only representatives of the genus, of which no trace had been discovered, either in the Silurian strata, so rich in crinoids, or in the Carboniferous series, where these fossils are also abundant.

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[1] When examined with a pocket magnifying glass, the plates of nearly all the specimens in the British Museum, now upwards of twenty in number, show a finely-striated ornamentation running in an obliquely-transverse direction across their surface. Probably the specimen examined by M. de Koninck may have been much rubbed upon its surface. In the publications of the Geological Survey of Canada, Decade III., "Figures and descriptions of Canadian organic remains," Montreal, 1858, p. 72, Mr. E. Billings, the accomplished palæontologist to that Survey, has figured in a small woodcut and described an anomalous and imperfect Cystidean, under the name of *Ateleocystites Huxleyi*. From the figure and description we are inclined to think it may hereafter be shown to be the "posterior" surface of a cystidean, identical with M. de Koninck's *Placocystites Forbesianus*; the more so as the plates are described by Mr. Billings as tranversely striated. But as the Canadian specimen is very imperfect, we think it would be very hazardous to assume from the figure alone that *Placocystites* (de Koninck, 1869) was synonymous with *Ateleocystites*, Billings, 1858.—Edit.

[2] One of the specimens in the Museum shows at least nine plates on its posterior surface.—Edit.

[3] Goldfuss Petrefact. Germ. Tome i. p. 213. Pl. lxiv. Fig. 6.

The discovery of a Carboniferous *Haplocrinus* offers a certain interest; it is to Mr. Parker that it is due. It is to his kindness that I owe the only specimen found by him in the Carboniferous Limestone of Bolland in Lancashire, amongst a considerable number of other fossils of less importance.

Haplocrinus granatum, de Kon. Calyx small, ventral part subglobular, hemispherical, buccal part or dome depressed, pyramidal, with a pentagonal base. Surface smooth to the naked eye, but when examined with the magnifying glass, one discovers some slight irregular rugosities. The base is relatively little elevated, and the part by which it has been articulated to the stalk is rather deeply hollowed, and is surrounded by a small circular burr. Its outline is irregular, two of the sides of the pentagon which form its projection are smaller than the three others, which are of about equal dimensions.

The three sub-radial pieces are very much broader than long; they are pentagonal, but the angle made by the remainder of the borders attached to the basal pieces is very obtuse. The fine radial pieces are relatively very large, and form alone the greatest part of the calyx; their surface is slightly rugose, their form is pentagonal, and the superior border is undulated. On the median part of this border, to which the arms must have been articulated, one can detect a slight swelling, in which is hollowed out a small furrow, which continues up to the summit of the dome or vault.

The inter-radial pieces are five in number, and alternate with the radial plates. All are subtriangular, and very nearly of the same form and size—their lateral borders being bevelled, form, by their juxtaposition, the five radiating furrows seen on the vault, and to which I have already referred. Of the form and disposition of the jointed arms, I am unable to speak, as they are entirely wanting.

Compared with the species from the Eifel, this one can easily be distinguished by its general form, which is less globular, by the nearly complete absence of ornamentation on its surface, by the greater elevation of its dome, and above all by the peculiar form of the furrows which are scooped out upon it. It approaches more nearly to the *H. Clio* of Hall.

EXPLANATION OF PLATE VII.

Fig. 1. *Palæchinus sphæricus*, Scouler (nat. size), from the Carboniferous Limestone of Kirkby-Stephen, in Westmoreland. The original in the collection of Edward Wood, Esq , F.G.S., of Richmond, Yorkshire.

Fig. 2. *Placocystites Forbesianus*, de Kon., from the collection of John Gray, Esq. (now in the British Museum). Specimen of the natural size seen from the anterior side. *a*, anal aperture; *b*, ovarian orifice.

Fig. 3. The same specimen seen from the posterior side.

Fig. 4. " " " base.

Fig. 5. Transverse section, taken upon a line passing through the body near the anal aperture.

Fig. 6. *Haplocrinus granatum*, de Koninck, specimen of the natural size seen in profile.
Fig. 7. The same, greatly enlarged, seen from the same side.
Fig. 8. The same, of the natural size, seen from top of the vault or dome.
Fig. 9. The same, greatly enlarged, seen in the same position as in Fig. 8.
Fig. 10. The same, greatly enlarged, seen from the base of the Calyx.

[For procuring the necessary copies (printed from the original Plate in Brussels) to illustrate this paper, I am indebted to my friend, Mr. Edward Wood, of Richmond, and likewise to the kindness of the author of the paper, Prof. de Koninck, of Liége.]

III.—The Grit-rocks of the Eastern Border of North Wales.

By John Aitken, F.G.S.

The sandstone beds which skirt the eastern border of Wales, and stretch from a little south-west of the town of Oswestry to near the Point of Ayr, on the shores of the Irish Sea, a distance of upwards of 40 miles in a direct line, have for several years past been a source of perplexity to those who have investigated their peculiarities, and who have been interested in arriving at a determination of their true age and geological horizon.

Notwithstanding the difficulties which surrounded them they have been considered by the Geological Survey, and also by amateur geologists generally, as equivalents of the Millstone-grit formation of the Penine chain. This classification was doubtless adopted from the fact that, in the southern part of the district, in the tract lying between Oswestry and Llangollen, this group of beds is principally made up of sandstones, whilst further north, in the neighbourhood of Mold, the arenaceous character, although considerably modified by the intercalation of calcareous and argillaceo-calcareous layers, still forms a prominent feature; and also from the further fact of their being situated immediately subjacent to the Coal-measures.

Having recently had an opportunity of examining this group of rocks, at various parts of its extent, in the southern portion, under the able guidance of Mr. D. C. Davies, of Oswestry, and in the Mold district, in company with Mr. G. H. Morton, F.G.S., of Liverpool; and having subsequently instituted some comparisons between them and the Millstone-grits of Lancashire and Yorkshire, with which I have had some acquaintance for several years past, and also with the Yoredale series, which I have examined at various places, the conviction has forced itself upon me, that the classification usually adopted with respect to these sandstones cannot be satisfactorily maintained, whether viewed in relation to their lithological character, strategraphical position, or to their contained fossils, but that their general characteristics have much more of the Yoredale type than of the Millstone-grit; I nevertheless feel considerable diffidence in placing myself in opposition to the authorities who have written on this subject, and particularly in dissenting from the conclusions of Mr. D. C. Davies, who has had extensive opportunities of studying this series of beds, and who has recently given expression to his views respecting them in the pages of the Geological Magazine.[1]

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[1] The Millstone-Grits of the North Wales Border, by D. C. Davies, of Oswestry. Vol. vii., pp. 68 and 122.

In the southern portion of the area occupied by these grits, probably no one will contend that the Carboniferous series is complete, for, separating the Mountain limestone from the Coal-measures of that district, only one set of beds precisely similar in character, and evidently belonging to the same series, is found; it therefore necessarily follows that one of the subdivisions must be abandoned, and the question then arises, which of the two shall be given up, the Millstone-grit or the Yoredale section?

It is not unreasonable to suppose that, had the Yoredale rocks been entirely absent from this area, and the Millstone-grits been deposited immediately upon the surface of the Carboniferous limestone, some evidence of this interruption to the regular order of things would have been left at the junction of the two, either in the form of an eroded limestone surface, unconformity of strata, or in some other unmistakable way, representing the break in time, and the abrupt transition from a condition of things in which the calcareous element predominated, to one in which arenaceous rocks were almost exclusively deposited; yet no such sign exists, the change from one formation[1] to the other is quite uniform and gradual, although the passage beds are only thin and feebly represented; the limestone beds near the top not only become steadily more arenaceous, and split up into thin layers, intercalated with bands of shale, but also exhibit a steady change of colour, from grey through yellow and purplish, into the thin purple sandstones which form the base of the overlying grits, the transition in both cases being perfectly gradual and regular.[2]

I had no opportunity of seeing a section where the Coal-measures come on over the grits, and am therefore unable to say whether the same remarks apply in this case or not as to the nature of the transition from one to the other. I, however, observed that, in a horizontal section given by Mr. Davies in the Geol. Mag., Vol. VII. p. 69, Fig. 1, the Coal-measures are shown as resting unconformably upon the top of the Oswestry sandstone; and I have also in my possession a sketch by the same author, showing in a still more pronounced manner the existence of an unconformity between the Coal-measures and the subordinate grits at Sweeney Mountain. If this be so the arguments in favour of removing these arenaceous beds from the Millstone-grit formation, and of including them in the Yoredale series, is greatly strengthened.

If we next consider the texture and general character of these sandstones we shall also find that they correspond much more closely with the Yoredale than the Millstone-grits. In Lancashire and Yorkshire, and indeed throughout its whole extent on both flanks of the Penine chain, the usual characteristic of the last-named ock is that of a strong, massive quartziferous grit, often conglomeratic and but rarely fine or flaggy. In some cases it is so compact that the fracture at first glance presents somewhat of a granitic r sub-crystalline appearance, whilst, on the other hand, the Yoredale sandstones are generally fine-grained, flaggy, ripple-marked, rown rocks, with which are usually associated beds of black shale, imestone (not unfrequently earthy and somewhat impure), and ccasionally, towards the north, with thin seams of coal, the whole orming the Yoredale series.[1]

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[1] I here adopt the usual phraseology which represents the Carboniferous Limestone and the Yoredale rocks as distinct formations, this is however merely a conventional division for the convenience of classification, beyond which it has no significance.

[2] The regular passage from the Limestone rocks to the overlying Grit will be rendered apparent by consulting the two sections given by D. C. Davies in the Geological Magazine, Vol. VII., p. 69, Fig. 2, and p. 70, Fig. 3.

If we compare the Oswestry sandstones[2] with the grits of Yoredale eries we shall find that they fall in very well generally with that ormation, whilst they are wholy different in character and appearance from the Millstone-grits. It will be observed that we shall find he similarity is still more striking by instituting a comparison etween the group of beds resting upon the thick, buff, massive imestone, in the Mold district, and the Yoredale rocks, which presents the following succession of strata in ascending order:—Immediately over the thick limestone come three or four beds of fine-grained, brown, flaggy grit-rock, separated by beds of black shale, he whole of which gradually become more and more calcareous as e ascend in the series; upon these rest some black shales, which, in heir turn, are overlaid by beds of limestone, about 150 feet in thickness (which become highly siliceous at the top), parted by layers of lack fossiliferous shales, the whole surmounted by a sandstone rock, which Mr. Morton considers belongs to the Millstone-grit series; ven Mr. Davies, who, although adopting the generally-received lassification of these rocks, appears to entertain some doubt as to its orrectness, for, speaking of them in the neighbourhood of Mold, he hus expresses himself:—"So rapid is the increase of calcareous matter n the last 15 miles that it is difficult, when looking at the Mold ection, to say whether we have, as shown on the Government Survey maps, Millstone-grits with bands of limestone, or limestones nterstratified with beds of grit."[3]

The higher beds of the thick limestone proper become arenaceous, nd are charged with corals and shells in such abundance, that in ome places the rock appears to be almost entirely composed of their remains. No one can examine a surface of this rock, which has been exposed for some time to the weather, without being struck with the thought that it must, at a former period of the world's history, have formed a portion of a great palæozoic coral reef, thus furnishing conclusive evidence of a shallow sea and a change of conditions, and which probably represents the first step towards that complete change which resulted in the deposition of the arenaceous strata which now rest upon this ancient sea-beach.

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[1] The following passage, extracted from Phillips's Geology of Yorkshire, will serve as an illustration of this subject. In describing the Yoredale series, at p. 36, the author observes—"The Southern series (Craven) consists almosts entirely of argillaceous laminated rocks, locally changing to Limestone and Chert, generally productive of ironstone, and containing marine exuviæ. The Northern type (Teesdale) consists of the same argillaceous basis (less calcareous, and of a coarser grain), with the addition of many layers of Sandstone, distinct beds of Limestone, thin coal seams, and sand plants;" see also section at page 37 of the same work. Also at page 6 of the Memoirs of the Geological Survey of North Derbyshire and the adjoining parts of Yorkshire, by A. H. Green, F.G.S., C. Le Neve Foster, B.A., etc., and J. R. Dakyns, M.A.

[2] See section and description, by A. H. Green, M.A., F.G.S., of the "Lower Carboniferous rocks of North Wales," Geological Magazine, Vol. IV., p. 12; also description by D. C. Davies, Geological Magazine, Vol. VII., pp. 70 to 72.

[3] Geological Magazine, Vol. VII., p. 73.

Then, again, if we glance at the fossils discovered in the Oswestry sandstones, a list of which, containing sixteen species, was given by Mr. W. Prosser, F.G.S., in the year 1865 (page 110, Vol. II. of the Geol. Mag.), to which Mr. D. C. Davies has subsequently furnished six additional species, we shall find (with the exception of the doubtful shell named *Schizodus*) that they are all forms found in, and characteristic of, the Carboniferous Limestone.

The fossils contained in the list furnished by Professor Phillips, in his Geology of Yorkshire, and from the Millstone-grits of that county, were principally derived from strata, which have, since he wrote, been eliminated from that formation by a more recent classification, and included in the Yoredale series; consequently it has no longer any value as determining the fauna pertaining to the Millstone-grit group.

In order to afford an opportunity of comparing the fauna found in the shales interstratified with the Millstone-grits of the Northern counties, with that from the grits on the Welsh border, before referred to, I may be allowed to quote the following passage, taken from the inaugural address I delivered to the Manchester Geological Society in November last.[1] "The series of grits and shales of the northern counties, has generally been considered as destitute of all animal life; more recent discoveries have, however, revealed to us the fact, that, during the period of their deposition, the co-existing fauna was by no means limited either in specific forms or individual numbers; true it is that the coarse sandstones of this series have not as yet yielded any undoubted examples of the animal life of the period. On the other hand, the interbedded black carbonaceous shales *are* gradually becoming known to geologists as the receptacles of a varied fauna. From a layer of calcareous nodules enclosed in a fossiliferous bed of higher Millstone-grit shales, at Rough Lee in Pendle, I have succeeded in collecting five or six species of *Goniatites*, two or three of *Orthoceratites*, two of *Posidonomya*, two of *Aviculopecten*, together with other forms; in addition to which, the late Mr. Joseph Whitaker of Burnley obtained two small Gasteropods and a fish tooth of the genus *Cladodus*. More recently, Mr. Tiddeman of the Geological Survey, and Mr. James Eccles of Blackburn, have discovered abundance of encrinital remains in beds of shale of this age; the former on the banks of the Ribble, near Rochester, and the latter near Roach Bridge, on the river Darwen; and near the same place, some years ago, Mr. Binney mentions meeting with *Goniatites* in a bed of black shale, which is now ɔgnized as belonging to this formation." From this quotation it l be evident that the fossils found in the Millstone-grit shales of ɔcashire, have a totally different facies from those obtained from Sandstones of the Welsh border, the whole of the former, with haps the single exception of the encrinital remains, are forms onging to and found in the Lower Coal-measures, and also more ringly in the subjacent Yoredale shales.

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[1] Transactions Manchester Geological Society, Vol. VII., p. 25.

ince writing the principal part of this paper, in looking about information on this subject, I have come across the observations Mr. J. H. Green, M.A., F.G.S., "on the Lower Carboniferous ks of North Wales," who it appears had arrived at a similar clusion, three years ago,[1] to that I had formed on independent unds as to the age of these rocks. I also notice that, in a section ompanying a paper on "Palæontological Observations on the nestones in Flintshire," by Mr. G. H. Morton, F.G.S., 156 feet the Upper Mountain Limestone is designated Yoredale series.[2]

Although I may not have been able to adduce evidence which will considered conclusive as to the Yoredale age of the rocks in stion, I trust I have succeeded in placing before the readers tain facts calculated to show that the conclusions previously ived at are open to very grave doubts and serious objections, and t, at all events, further and more decided proofs are necessary to tify their retention as part of the Millstone-grit formation.

IV.—ON SUPPOSED PHOLAS BURROWS IN DERBYSHIRE.

By T. G. BONNEY, M.A., F.G.S.

URING a short vacation visit to Derbyshire I have had the opportunity of making some further notes on burrows in nestone rocks, which may be worth recording. These burrows, will be remembered, have been attributed by Messrs. Darbyshire,[3] ckintosh,[4] and others, to the action of Pholades, a conclusion ich I ventured to oppose, after an examination of several instances the neighbourhood of Llandudno.[5] Mr. Darbyshire calls attenn, in his paper, to the occurrence of these burrows near Buxton, Grin Edge and Harper Hill, at a height of about 1400 feet ove the sea. I was therefore fully prepared to meet with them in Carboniferous Limestone in other parts of the county.

The first distinct case which I observed was in Millers Dale. I cended into the valley, from the railway station, to the road ich runs along the northern bank of the Wye, to Litton Mills, and rarely more than a few feet above the water. Millers Dale in s neighbourhood is clearly an instance of subaerial aqueous denuion, a somewhat irregular example of the Y type of valleys; the vest part being at times a well-marked gorge, with precipitous es, and bed but little wider than the existing stream. A short distance below the railway bridge is a small inn—"The Anglers;" about a hundred yards beyond which I came upon some well-marked burrows. Hereabout the northern slope of the valley descends to the river as a steep bank somewhat broken by outcropping beds of rock. The road to Litton Mills appears to be partly cut out of this slope, partly formed by an embankment constructed of the excavated material. Below it is a very narrow slip of flat land; then comes the stream. The other bank of this is formed by a grassgrown talus, leading up to a limestone precipice of considerable height, above which rise the long slopes of the upper and more open parts of the valley,

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[1] GEOLOGICAL MAGAZINE, Vol. IV., p. 11.

[2] Transactions Liverpool Geological Society, 1868 and 1869, p. 75.

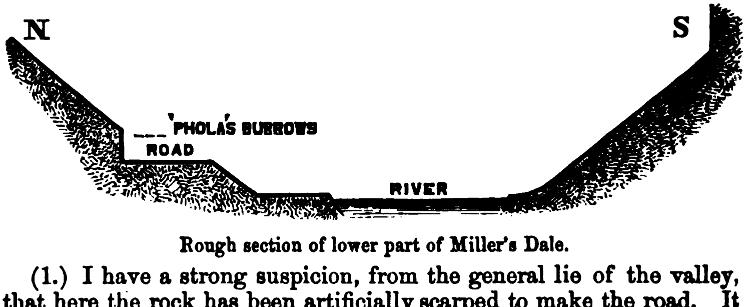
[3] Lit. and Philosoph. Soc. of Manchester, Memoirs, Ser. iii. vol. iv.

[4] GEOLOGICAL MAGAZINE, Vol. VII. p. 47.

[5] GEOLOGICAL MAGAZINE, Vol. VI. p. 483. See also Mr. Rofe's paper, vol. vii. p. 4.

The burrows were in the upper part of a low cliff or scarp of limestone by the side of the road, and about four and a-half feet above it. They were driven into a stratum which, as it seemed, was more affected by the weather than the very compact layer below. The burrowing animals appeared to have availed themselves of the weathered parting of the two beds, and had driven their burrows, more or less vertically, into the upper stratum, from any point where they could gain a "coigne of vantage." Several of the holes were simply channels sunk into the rock, the extremities being rounded. After carefully examining these, I am of opinion that they have been formed as channels on the surface, and are not, as has been suggested by Mr. Rofe, burrows partly exposed by weathering. These and the burrows, as I have said, were generally directed upwards; but their axes were usually more or less curved, and their shape was altogether more irregular than I have been accustomed to see in Pholas holes; in one case two or three distinct burrows (as has been noticed by Mr. Rofe) radiated from a single aperture. In a word, the burrows presented precisely the same features as did those to which I called attention in the paper already mentioned.

I saw some other burrows as I went down the Dale, and probably a more careful search would show them to be abundant; for I only examined one or two places where I thought there was a chance of obtaining some fresh facts, for this instance was enough to suggest the following difficulties in the Pholas theory.



Rough section of lower part of Miller's Dale.

(1.) I have a strong suspicion, from the general lie of the valley, that here the rock has been artificially scarped to make the road. It is of course just possible that this face may be a natural cliff, of which the roadmakers have availed themselves; but the annexed section (a rough diagram not drawn to scale) certainly suggests the contrary.

In many places the rock is clearly scarped, but in this it is rather more weather-worn than elsewhere. Of course if this cliff has been formed by the erosive action of pick and crowbar, there is an end of the Pholas theory.

(2.) But even waiving this objection, and supposing the rock-face, like many others in the valley, to be one due to natural forces, is it likely that burrows of Pholades should exist in such a situation? The gorge, as I have said, is one, if ever I saw an example, of subaerial fluviatile erosion, The holes are not a dozen feet above the present level of the stream. If, then, the existing Millers Dale had ever been a land-locked fjord, might we not expect to discover some traces of the deposition which must then have been going on from lateral streams? I could not see a trace of a terrace of river drift, and so convinced am I that the greater part (if not the whole) of the gorge has been cut out by stream, rain, and frost, since Derbyshire had its last sea bath, that I should as soon expect to find a whale's skeleton in the Combe de Queyraz, or any other Alpine glen, as a Pholas burrow at the bottom of Millers Dale.

Next day, while descending Salter's Lane, towards Matlock Bridge, I observed on the pastures on either side of the road a number of large blocks of limestone, many of them from ten to twenty cubic feet in contents, which no doubt mark the outcrop of a bed differing somewhat in mineral character from those above and below. They form an irregular band on the hill side, between the upper and lower sheets of toadstone, very near to the letter S on the Geological Survey Map, The limestone, though compact internally, has a soft chalky appearance externally, and I felt convinced, from its general appearance, that here, if anywhere, I should find burrows. It needed little search to discover them, for they were abundant on either side of the road. Here again, although they were not restricted to any one face of the rocks, the burrowing animals appeared generally to have selected some existing crack, depression, or underside of a projection, as a lodgement in commencing their task. As at Llandudno, very many were quite near to the ground, and not a few were only channels, without any signs of having ever been more deeply burrowed. Most of them were directed vertically upwards, but there was just the same irregularity in direction and in section that I have already noticed. One specimen, which now lies before me, contains about fourteen or fifteen of these burrows, varying in depth from barely half an inch to nearly two and a-half inches, most of which are driven upwards; but so intricate are they, and so honeycombed are some parts of the rock, that no description, and not even a drawing, could give a true notion of their arrangement. In several cases one burrow has encroached on the party wall which separated it from another, so that the two are either thrown into one for some distance, or else joined by a small circular aperture. I did not find any helices in those that I probed; this, however, may be due to the season of the year; but after examining these instances my conviction is stronger than ever that no animal of the Pholas form could have produced such excavations, while a

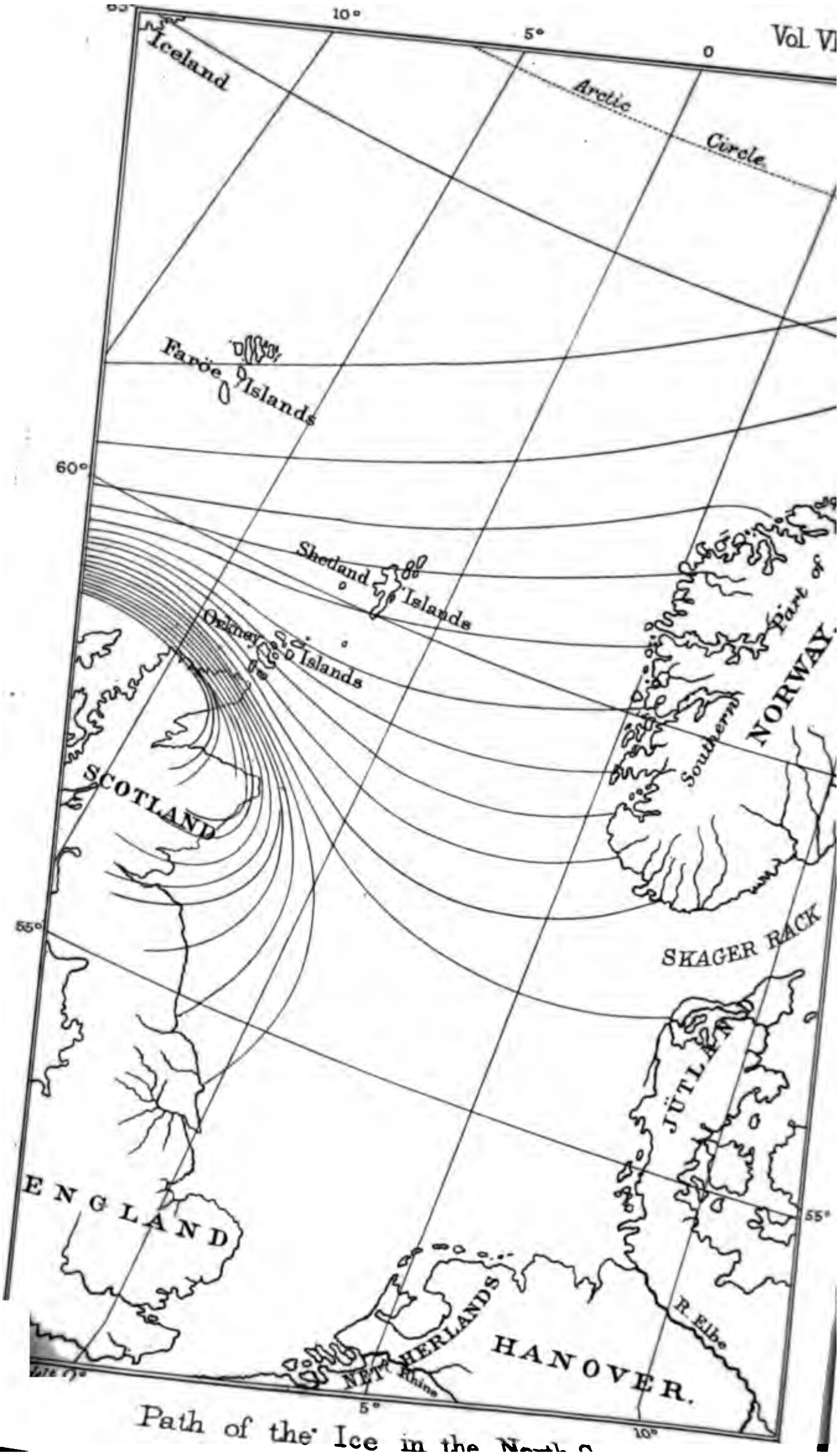
Helix, supposing it to have the power of either chemically dissolving or mechanically abrading the stone, could readily have accomplished the work. I am unable to state the height of these blocks above the sea, but their position is considerably more elevated than the High Tor, which rises about 350 feet above the river Derwent. I submit, therefore, that by confirming my former observations as to the irregularity of form and general verticality of direction of these burrows, and by discovering them on a scarp, probably artificial, and certainly at the bottom of a gorge of subaerial erosion, I have shown that the Pholas theory is untenable.

V.—NOTE ON A PRE-HISTORIC DWELLING AND KITCHEN-MIDDEN, ON THE COAST OF HADDINGTONSHIRE.

BY J. W. LAIDLAY, F.S.A., F.G.S.

I HAVE much pleasure in furnishing you with the accompanying rough sketch of the rock on which were discovered, some time ago, the remains of a building and its "kitchen-midden," belonging to a remote period, and in which you took some interest in respect of its bearing upon a geological question of the day, namely, the supposed rise of our coasts within the historical period. The rock in question, situated about three miles east of North Berwick, on the south side of the Frith of Forth, is isolated at spring-tides, but is not at other times separated by the sea from the main-land. The remains of former ages found upon the rock, were, first, the foundations of an ancient building, consisting of walls formed of stones, selected apparently from the neighbouring beach, and joined together with only earth or mud; being two to three courses in height, but concealed till recently by a thick coating of turf; a large quantity of very rude pottery in frag-

Peninsula on which Pre-Historic dwelling was discovered near Seacliff, Haddingtonshire.



Path of the Ice in the North S

ments, and, for the most part, roughly moulded by the hands; a number of implements of bone, such as needles, arrow-heads, combs, knives, chisels, etc., very similar to those found in the Swiss Lakes; a vast quantity of bones of oxen (of several varieties, including *Bos longifrons*), sheep, goats, deer, swine, dogs, &c.; of shells, in great abundance, especially those of the *Patella* and *Littorina*; a very rude querne, etc. All of these have been deposited in the Museum of the Society of Antiquaries of Scotland, and are considered, by those best qualified to judge, as belonging to an age as remote as the Roman period, or perhaps extending even beyond it; an opinion confirmed, perhaps, by the absence of every trace of metallic implements, notwithstanding the most diligent efforts to discover any such by laboriously sifting the whole of the soil, within and about the building.

Now the peculiar geological interest of this ancient habitation consists in this: that it lies on the rock, not more, as to its lower part, than 22 or 23 feet above high-water mark; and assuming, as I think we fairly may, that its age extends beyond the historical period, it certainly does seem to me to furnish a very cogent argument against the theory of any material rise of the land since that time. Even as it is, the spray during storms sweeps so unpleasantly over it, that it is difficult to conjecture why so exposed a site should be chosen for a dwelling at all. Were it, however, but a little further depressed the sea would, in bad weather, make a clean breach over it, and render habitation there simply impossible.

VI.—THE BOULDER-CLAY OF CAITHNESS A PRODUCT OF LAND-ICE,

By JAMES CROLL, of the Geological Survey of Scotland.

(PLATE X.)

PART II.

(*Continued from the May Number, p.* 209.)

WE must consider that the ice from Scotland and England was but a fraction of that which entered the North Sea. The greater part of the ice of Scandinavia must have gone into this sea, and if the ice of our island could not find water sufficiently deep in which to float, far less would the much thicker ice of Scandinavia do so. The Scandinavian ice, before it could break up, would thus, like the Scottish ice, have to cross the bed of the North Sea and pass into the Atlantic. It could not pass to the north, nor to the north-west, for the ocean in these directions would be blocked up by the Polar ice. It is true that in the southern part of Norway there is a comparatively deep trough of from one to two hundred fathoms, extending along the shore. But this is evidently not deep enough to have floated the Scandinavian ice-sheet. But even supposing it had been sufficiently deep, the floating ice must find its way to the Atlantic, and this it could not have done without passing along the coast. But its passage would not only be obstructed by the mass of ice continually protruding into the sea directly at right angles to its course, but it would be met by the still more enormous masses of ice coming off a coast line of more than 700 miles beyond the most northern point shown in the accompanying diagram. And, besides this, the ice entering the Arctic Ocean from Lapland and the northern parts of Siberia, except the very small portion which might find an outlet into the Pacific through Behring's Straits, would have to pass along the Scandinavian coast in its way to the Atlantic. No matter what the depth of this trough may have been, if the ice from the land, after entering it, could not make its escape, it would continue to accumulate till the trough became blocked up; after this, the great mass from the land would move forward as though the trough had no existence. The only path for the ice would be by the Orkney and Shetland Islands. Its more direct and natural path would, no doubt, be to the south-west, in the direction of our shores; and in all probability, had Scotland been a low flat island, instead of being a high and mountainous one, the ice would have passed completely over it. But its mountainous character, and the enormous masses of ice at the time proceeding from its interior, would effectually prevent this, and the ice of Scandinavia would be compelled to move round by the Orkney Islands. The two huge masses of moving ice—the one from Scotland and the much greater one from Scandinavia—would meet in the North Sea, probably not far from our shores, and would move, as represented in the diagram, side by side northwards into the Atlantic as one gigantic glacier.

This cannot be regarded as an anomalous state of things. In Greenland and in the Antarctic continent the ice does not break up into icebergs on reaching the sea. It moves along the sea bottom in a continuous mass until it reaches water sufficiently deep to float it. It is quite possible that the ice at the present day may nowhere traverse a distance of three or four hundred miles of sea bottom, but this is wholly owing to the fact that it finds water sufficiently deep to float it before having travelled far. Were Baffin's Bay and Davis's Straits, for example, as shallow as the North Sea, the ice of Greenland would not break up into icebergs in these seas, but cross in one continuous mass to and over the American continent.

The medial line of the Scandinavian and Scottish ice-sheets would be situated not far from the east coast of Scotland. The Scandinavian ice would press up as near to our coast as the resistance of the ice from this side permitted. The enormous mass of ice from Scotland, pressing out into the North Sea, would compel the Scandinavian ice to move round by the Orkneys, and would also keep it at some little distance from Scotland. Where, on the other hand, there was but little resistance offered by ice from the interior of this country (and this might be the case along many parts of the English coast), the Scandinavian ice might reach the shores, and even overrun the country for some distance inland.

There is another cause which might tend to force the Scandinavian ice down in the direction of our shores. The western half of Gothland is striated in the direction of N.E. and S.W., and that this has been effected by a huge mass of ice covering the country, and not by local glaciers, is apparent from the fact observed by Robert Chambers,[1] that the general direction of the groovings and striæ on the rocks, bears little or no relation to the conformation of the surface, showing that the ice was of sufficient thickness to move straight forward, regardless of the inequalities of the ground.

At Gottenburg, on the shores of the Cattegat, and all around Lake Werner and Lake Wetter, the ice-markings are of the most remarkable character, indicating in the most decided manner that the ice came from the interior of the country to the north-east in one vast mass. All this mass of ice must have gone into the shallow Cattegat, a sea not sufficiently deep to float even an ordinary glacier. The ice coming off Gothland would therefore cross the Cattegat, and thence pass over Jutland into the North Sea. After entering the North Sea, it would be obliged to keep between our shores and the ice coming direct from the western side of Scandinavia.

But this is not all, a very large proportion of the Scandinavian ice would pass into the Gulf of Bothnia, where it could not possibly float. It would then move south into the Baltic as land-ice. After passing down the Baltic, a portion of the ice would probably move south into the flat plains in the north of Germany, but the greater portion would keep in the bed of the Baltic, and of course turn to the right round the south end of Gothland, and thence cross over Denmark into the North Sea. That this must have been the path of the ice is, I think, obvious from the observations of Murchison, Chambers, Hörbye, and other geologists. Sir Roderick Murchison found—though he does not attribute it to land-ice—that the Aland Islands, which lie between the Gulf of Bothnia and the Baltic, are all striated in a north and south direction.[2]

Upsala and Stockholm, a tract of flat country projecting for some distance into the Baltic, is also grooved and striated, not in the direction that would be effected by ice coming from the interior of Scandinavia, but north and south, in a direction parallel to what must have been the course of the ice moving down the Baltic.[3] This part of the country must have been striated by a mass of ice coming from the direction of the Gulf of Bothnia. And that this mass must have been great is apparent from the fact that Lake Malar, which crosses the country from east to west, at right angles to the path of the ice, does not seem to have had any influence in deflecting the icy-stream. That the ice came from the north and not from the south is also evident from the fact that the northern sides of rocky eminences are polished, rounded, and ice-worn, while the southern sides are comparatively rough. The northern banks of Lake Malar, for example, which, of course, face the south, are rough, while the southern banks, which must have offered opposition to the advance of the ice, are smoothed and rounded in a most singular manner.

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[1] Tracings of the North of Europe, 1850, pp. 48–51.

[2] Quart. Jour. Geol. Soc., vol. ii. p. 364.

[3] Tracings of the North of Europe by Robert Chambers, pp. 259, 285. Observations sur les phénomènes D'Erosion en Norwege, by M. Hörbye, 1857.

Again, that the ice, after passing down the Baltic, turned to the right along the southern end of Gothland, is shown by the direction of the striæ and ice-groovings observed on such islands as Gothland, Oeland, and Bornholm. Sir R. Murchison found that the island of Gothland is grooved and striated in one uniform direction from N.E. to S.W. "These groovings," says Sir Roderick, "so perfectly resemble the flutings and striæ produced in the Alps by the actual movement of glaciers, that neither M. Agassiz nor any one of his supporters could detect a difference." He concludes, however, that the markings could not have been made by land-ice, because Gothland is not only a low, flat island in the middle of the Baltic, but is "at least 400 miles distant from any elevation to which the term of mountain can be applied." This, of course, is conclusive against the hypothesis that Gothland and the other islands of the Baltic could have been glaciated by ordinary glaciers; but it is quite in harmony with the theory that the Gulf of Bothnia and the entire Baltic were filled with one continuous mass of land ice, derived from the drainage of the greater part of Sweden, Lapland, and Finland. In fact, the whole glacial phenomena of Scandinavia are inexplicable on the hypothesis of local glaciers.

That the Baltic was completely filled by a mass of ice moving from the north is further evidenced by the fact that the mainland, not only at Upsala, but at several places along the coast of Gothland, is grooved and striated parallel to the shore, and often at right angles to the markings of the ice from the interior, showing that the present bed of the Baltic was not large enough to contain the icy stream. For example, along the shores between Kalmar and Karlskrona, as described by Sir Roderick Murchison and by M. Hörbye, the striations are parallel to the shore. Perhaps the slight obstruction offered by the island of Oeland, situated so close to the shore, would deflect the edge of the stream at this point over on the land. The icy stream, after passing Karlskrona, bent round to the west along the present entrance to the Baltic, and again invaded the mainland, and crossed over the low headland of Christianstads, and thence passed westward in the direction of Zealand.

This immense Baltic glacier would in all probability pass over Denmark, and enter the North Sea somewhere to the north of the River Elbe, and would then have to find an outlet to the Atlantic through the English Channel, or pass in between our eastern shores and the mass from Gothland and the north-western shores of Europe.

Taking all these various considerations into account the conclusion is inevitable that the great masses of ice from Scotland would be obliged to turn abruptly to the north, as represented in the diagram, and pass round into the Atlantic in the direction of Caithness and the Orkney Islands.

If the foregoing be a fair representation of the state of matters, it is physically impossible that Caithness could have escaped being overridden by the land-ice of the North Sea. Caithness, as is well known, is not only a low, flat tract of land, little elevated above the sea level, and consequently never could have supported large glaciers; but, in addition, it projects in the form of a headland across the very path of the ice. Unless Caithness could have protected itself by pushing into the sea glaciers of one or two thousand feet in thickness, it could not possibly have escaped the inroads of the ice of the North Sea. But Caithness itself could not have supported glaciers of this magnitude, neither could it have derived them from the adjoining mountainous regions of Sutherland, for the ice of this county found a more direct outlet than along the flat plains of Caithness.

The shells which the Boulder-clay of Caithness contains have thus evidently been pushed out of the bed of the North Sea by the land-ice which formed the clay itself.

The fact that these shells are not so intensely Arctic as those found in some other quarters of Scotland is no evidence that the clay was not formed during the most severe part of the glacial epoch, for the shells did not live in the North Sea at the time that it was filled with land-ice. The shells must have belonged to a period prior to the invasion of the ice, and consequently before the cold had reached its greatest intensity. Neither is there any necessity for supposing the shells to be pre-glacial. Of late a great many facts have been observed in connection with the glacial drift of Scotland, a number of which have not yet been made public, that conclusively prove, from the character of the organic remains found, that the glacial epoch must have been broken up by several periods of long duration, when the climate was mild and equable, if not positively warm. In so far as Scotland is concerned, it would be hazardous to conclude that a plant or an animal is either pre-glacial or post-glacial simply because it may happen not to be of an Arctic or of a Boreal type.

The same remarks which apply to Caithness, apply to a certain extent to the headland at Fraserburgh. It, too, lay in the path of the ice, and from the direction of the striae on the rocks, and the presence of shells in the clay, as described by Mr. Jamieson, it bears evidence also of having been overridden by the land-ice of the North Sea.

In fact we have, in the invasion of Caithness and the headland at Fraserburgh by the land ice of the North Sea, a repetition of what we have seen took place at Upsala, Kalmar, Christianstads, and other flat tracts along the sides of the Baltic.

The scarcity, or perhaps entire absence of Scandinavian boulders in the Caithness clay, is not in any way unfavourable to the theory, for it would only be the left edge of the North Sea glacier that could possibly pass over Caithness; and this edge, as we have seen, was composed of the land-ice from Scotland. We might expect, however to find Scandinavian blocks on the Shetland and Faroe Islands.

The Shetland and Faroe Islands Glaciated by Land-ice.

It is also worthy of notice that the striae on the rocks in the Orkney, Shetland, and Faroe Islands, all point in the direction of Scandinavia, and are what would be affected by land-ice moving in the paths indicated in the diagram. And it is a fact of some significance, that when we proceed north to Iceland, the striae, according to the observations of Robert Chambers, seem to point towards North Greenland. Is it possible that the entire Atlantic, from Scandinavia to Greenland, was filled with land-ice! Astounding as this may at first appear, there are several considerations which render such a conclusion probable. The observations of Chambers, Peach, Hibbert, Allan, and others, show that the rocky face of the Shetland and Faroe Islands has been ground, polished, and striated in a most remarkable manner. That this could not have been done by ice belonging to the islands themselves is obvious, for these islands are by far too small to have supported glaciers of any size, and the smallest of them are striated as well as the largest. Besides, the uniform direction of the striae on the rocks shows that it must have been effected by ice passing over the islands. That the striations could not have been effected by floating icebergs at a time when the islands were submerged is, I think, equally obvious, from the fact that not only are the tops of the highest eminences ice-worn, but the entire surface down to the present sea level is smoothed and striated; and these striations conform to all the irregularities of the surface. This last fact Mr. Geikie has clearly shown is wholly irreconcilable with the floating-ice theory.[1] Mr. Peach[2] found vertical precipices in the Shetlands grooved and striated, and the same thing was observed by Mr. Thomas Allan on the Faroe Islands.[3] That the whole of these islands have been glaciated by a continuous sheet of ice passing over them was the impression left on the mind of Robert Chambers after visiting them.[4] This is the theory which alone explains all the facts. The only difficulty which besets it is the enormous thickness of the ice demanded by the theory. But this difficulty is very much diminished when we reflect that we have good evidence, from the thickness of icebergs which have been met with in the Southern Ocean,[5] that the ice moving off the Antarctic continent must be in some places considerably over a mile in thickness. It is then not so surprising that the ice of the glacial epoch, coming off Greenland and Northern Europe, should not have been able to float in the North Atlantic.

Why the Ice of Scotland was of such Enormous Thickness.

The enormous thickness of the ice in Scotland, during the glacial epoch, has been a matter of no little surprise. It is remarkable how an island, not more than 100 miles across, should have been covered with a sheet of ice so thick as to bury mountain ranges more than 1,000 feet in height, situated almost at the sea-shore, while tracts of country so near as the south of England and north of France, should have escaped glaciation altogether. But all our difficulties disappear when we reflect that the seas around Scotland, owing to their shallowness, were, during the glacial period, blocked up with solid ice. Scotland, Scandinavia, and the North Sea, would form one immense table-land of ice, from 1,000 to 2,000 feet above the sea level. This table-land would terminate in the deep waters of the Atlantic by a perpendicular wall of ice, extending probably from the west of Ireland away in the direction of Iceland. From this barrier icebergs would be continually breaking off, rivalling in magnitude those which are now to be met with in the Antarctic Seas.

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[1] Glacial Drift of Scotland, p. 29.

[2] GEOLOGICAL MAGAZINE, vol. ii., p. 343. Brit. Assoc. Rep., 1864 (sections), p. 59.

[3] Trans. Roy. Soc., Edin., vol. vii., p. 265.

[4] Tracings of Iceland and the Faroe Islands, p. 49.

[5] *Meteorological* Papers published by the Board of Trade. No. 12. 1865.

The Great Extension of the Loess Accounted For.

An effect which would result from the blocking up of the North Sea with land-ice, would be that the waters of the Rhine, Elbe, and Thames would have to find an outlet into the Atlantic through the English Channel. Mr. Geikie has suggested to me that if the Straits of Dover were not then open—quite a possible thing—or were they blocked up with land-ice, say by the great Baltic glacier crossing over from Denmark, the consequence would be that the waters of the Rhine and Elbe would be dammed back, and would inundate all the low-lying tracts of country to the south. This he thinks might account for the extraordinary extension of the Loess in the basin of the Rhine, and in Belgium and the north of France.

Postscript.—Since the foregoing was written I have met with a striking confirmation of the opinion expressed, "That the great mass of ice entering the Firths of Forth and Tay could not have been less than from 1,000 to 2,000 feet in thickness." One day lately, along with Mr. James Bennie, I ascended Allermuir, one of the hills forming the northern termination of the Pentland range, and was not a little surprised to find its summit ice-worn and striated. The top of the hill is composed of a compact porphyritic felstone, which is very much broken up; but, wherever any remains of the original surface could be seen, it was found to be polished and striated in a most decided manner. The striæ, we found, were all in one uniform direction, nearly east and west. On minutely examining the ice-markings we had no difficulty whatever in determining that the ice which effected them came from the west and not from the east. The direction of the striæ clearly shows that these markings must have been made at the time when, as is well known, the entire Midland valley was filled with ice, coming from the north-west Highlands. On the summit of the hill we also found patches of Boulder-clay in hollow basins of the rock. At one spot it was upwards of a foot in depth, and resting on the ice-polished surface. The clay was somewhat loose and sandy, which might be expected of a layer so thin, exposed to rain, frost, and snow during the long course of ages which must have elapsed since it was deposited there. Out of 100 pebbles collected from the clay, just as they turned up, every one of them, with the exception of three or four, composed of hard quartz, presented flattened and ice-worn surfaces; and forty-four were distinctly striated; in short, every stone, which was capable of receiving scratches and of retaining them, was striated. A number of these stones must have come from the Highlands to the north-west.

The height of Allermuir is 1617 feet, and, from its position, it is impossible that the ice could have gone over its summit, unless the entire Midland valley, *at this place*, had been filled with ice to [illegible] depth of more than 1,600 feet. The hill is situated about four or five miles to the south of Edinburgh, and forms, as has already been stated, the northern termination of the Pentland range. Immediately to the north lies the broad valley of the Firth of Forth, more than twelve miles across, offering a most free and unobstructed outlet for the great mass of ice coming along the Midland valley from the west. Now, when we reflect how easily ice can accommodate itself to the inequalities of the channel along which it moves, how it can turn to the right hand or to the left, so as to find for itself the path of least resistance, it becomes obvious that the ice never would have gone over Allermuir had not only the Midland valley at this point, but also the whole surrounding country been covered with one continuous mass of ice to a depth of more than 1,600 feet. But it must not be supposed that the height of Allermuir represents the thickness of the ice; for on ascending Scald Law, a hill four miles to the south-west of Allermuir, and the highest of the Pentland range, we found, in the debris covering its summit, hundreds of transported stones of all sizes, from one to eighteen inches in diameter. One of them, a Greenstone boulder about eighteen inches in diameter, which we dug up, was finely polished and striated. The height of the hill is 1,898 feet, consequently the thickness of the mass of ice covering the surrounding country, must have been at least 1,900 feet. How much thicker it was than this I have not as yet had any opportunity of ascertaining. But this is not all. Directly to the north of the Pentlands, in a line nearly parallel with the east coast, and at right angles to the path of ice from the interior, there is not, with the exception of the solitary peak of East Lomond, and a low hill or two of the Sidlaw range, an eminence worthy of the name of a hill nearer than the Grampians to the north of Forfarshire, distant upwards of 60 miles. This broad plain, extending from almost the Southern Highlands to the Northern, was the great channel through which the ice of the interior of Scotland found an outlet into the North Sea. If the depth of the ice in the Firth of Forth, which forms the southern side of this broad hollow, was at least 1,900 feet, it is not at all probable that its depth in the northern side, formed by the Valley of Strathmore and the Firth of Tay, and which lay more directly in the path of the ice from the North Highlands, could have been less. Here we have one vast glacier, more than sixty miles broad and 1,900 feet thick, coming from the interior of a country not much over sixty miles distant. Such a breadth and thickness of a glacier, proceeding from so small an area of drainage, is inconceivable upon any other hypothesis than that it was dammed back by land-ice from Scandinavia occupying the North Sea.

[*Note.*—The figures indicating the 65° of latitude, on the right side of Plate X. are misplaced; they should have been attached to the line beneath. The line against which they are placed is intended to indicate the course of the ice across the Faroe Islands. Also the curved lines, indicating the path of the ice from Scandinavia, should have extended down to at least latitude 55°.—J. C.]

VII.—ON THE LOWER SILURIAN ROCKS OF GALASHIELS.

By CHARLES LAPWORTH, Esq.

(*Continued from the May Number, p.* 209.[1])

(B.) *The Gala Group, continued:—*

(3.) *The Buckholm Sandstones.*—These beds are characterized by the evidence they afford of having accumulated in shallow water. They consist generally of gritty greywackes and light green or red, sandy, incoherent shales and mudstones.

The greywackes are usually schistose or thick-bedded, of purple or blue colours, and contain much mica; while the shales are exceedingly arenaceous, and are replaced at times by beds of mudstone or finely-levigated mud-shale, covered with the trails of Annelides, or spotted with little discolorations, due to the former presence of organic matter; while the whole set of strata is marked by its arenaceous and generally incoherent character, and the warm-coloured or rusty appearance of the rocks, so different from the cold, hard, forbidding aspect of the inferior strata. Yet, in spite of these more inviting characteristics, there are not many fossiliferous spots, though they are far more common than in the beds below. These beds are well exposed along the flanks of Buckholme and Meigle to Caddonfoot, and thence in the railway cuttings to Thornilee, and are recognizable at once by their peculiar character and the narrow bands of white or bright-coloured shale seen here and there among the dingier strata.

These beds, as might have been expected, are by far the most varied in their organic remains, and contain *Graptolites priodon*, *G. Sedgwickii*, principally *proteus*, *G. colonus* (Barr), *G. turriculatus* (Barr), *G. exiguus* (Nich.), which is found in myriads in some of the beds, *Retiolites perlatus* (Nich.), and *Rastrites Linnæi* (Barr), together with some small forms of *Diplograpsus* as yet undetermined; *Crossopodia Scotica* (M'Coy), *Nereites Cambrensis* (Murch.), *Nemertites tenuis* (M'Coy), *Trichoides ambiguus* (Hark.), *Protichnites sp.*, *Protovirgularia Harknessi*, traces of the swimming paddles of *Crustacea*, *Pterygotus ? sp.*, *Ceratiocaris* (three species), *Tentaculites sp.*, *Discinocaris Browniana* (Wood), *Fenestella*, together with many that are as yet indeterminable.

(4.) *Slates of Thornilee and the Grieston.*—I have placed these together because of their general similarity lithologically, both consisting of fine-grained shales, splitting into thin layers along the original lines of bedding, and from the circumstance that they both appear to be underlaid by the Buckholm beds or their representatives, and also from the fact that they both contain a fauna which most nearly approaches that of our higher beds. But I am compelled to admit that they may be two distinct deposits, separated by an enormous interval of time. In fact, much of the evidence points in the latter direction. The Thornilee slates seem to have been formed in shallow water, and are covered with tracks of Annelides, are often of a bright red or purple colour, show not the slightest trace of calcareous matter, and contain exceedingly few graptolites. On the other hand, the Grieston slates have generally a greyish blue appearance, have few traces of Annelides, contain pockets of calcareous matter, in certain beds are crowded with Graptolites, and are more than double the thickness of those of Thornilee.

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[1] The Map of the District described in this paper accompanied the first part, and will be found in the May Number (Plate VIII).—N.B. In the Scale of the Map for "2 miles to 2 inches," *read* "2 miles to 1 inch."

We have added nothing but *Protovirgularia Harknessi* tothe fauna found at Thornilee by Professor Nicol. These beds are cut through by a couple of igneous dykes, and have been much disturbed. They can be traced across the country for many miles in a N.E. direction, always associated with the intrusive dykes.

In the Grieston, in addition to the fossils mentioned by Nicol (*G. Sedgwickii*, *priodon*, and *Griestoniensis*), my friend, Mr. James Wilson, detected *Retiolites Geinitzianus* (Barr), and I have now to add *G. colonus* (Barr), the small variety of *Diplograpsus* of the Buckholm beds, the peculiar sponge-like reticulated fossil of the Abbotsford greywackes, associated with many others whose identity I have not as yet sufficient evidence to determine.

Of the beds that lie to the north of the Grieston slates I shall say nothing at present, as they seem to be entirely absent from the Gala district, and the Gala Group may provisionally be considered as terminated by the Thornilee slates, which appear to form the centre of a synclinal. Beyond them the beds to the north, as a rule, have a southward dip, and the Moffat shales are no doubt brought up again, as we have found pieces of black shale in the drift and water-laid gravel of Gala, containing *pristis*, *teretiusculus* (His.), *tamariscus*—all fossils of the Moffat shales.

Fossils.—The fossils of the Gala Group are exceedingly rare, a careful examination of every foot of the more shaly strata for a hundred yards sometimes failing to reveal even the trace of an organism. Whenever the almost universal argillaceous character of the shales is exchanged for one slightly more arenaceous, then the fossils begin to appear, and they are found in a thin sandy or micaceous layer of this kind of a fraction of an inch in thickness, when they are entirely absent from all the adjacent strata. Again, they are never wholly absent from the thin seams of slightly sandy carbonaceous shale that are more common towards the base of these deposits. In the finely-levigated shales, if we except those of Buckholm, they are never found.

The whole formation is remarkably deficient in calcareous matter. A few of the shales on the Gala Grit effervesce when treated with acids, and there are a few limy pockets in the Grieston, but not a yard of strata as yet exposed deserves the name of calcareous.

The following table shows the range and distribution of the fossils of the Gala Group, and I have inserted a couple of additional columns, the first showing if the fossil be found in the Coniston Series; the second, if it be present, in the Moffat Group :—

Table showing the Range and Distribution of the Fossils of the Gala Group.

	Black Shale.	Abbotsford Flag.	Abbotsford Greywacke.	Gala Grits.	Buckholm Sandstone.	Thornilee.	Grieston.	Coniston.	Moffat.
HYDROZOA, GRAPTOLITIDÆ, ETC.									
Cladograpsus capillaris (Carr)	x	...	...	...	...	...	...	...	x
Climacograpsus teretiusculus (His.)	x	...	...	...	...	...	...	x	x
Diplograpsus pristis (His.)	x	x	...	...	...	...	...	x	x
„ *tamariscus* (Nich.)	x	...	...	...	...	...	...	x	x
„ *vesiculosus* (Nich.)	x	...	...	...	...	...	...	x	x
„ *folium* (His.)	x	...	...	...	...	...	...	x	x
„ sp.	...	...	...	...	x	...	x	...	...
Rastrites maximus (Barr)	x	x	...	...	...	...	...	...	x
„ *Linnæi* (Barr)	x	x	...	...	x	...	...	x	x
Graptolites Sedgwickii (Port.)	x	x	x	x	x	x	x	x	x
„ (v.) *triangulatus* (Hark.)	x	x	x	...	...	...	...	x	x
„ (v.) *Proteus* (Barr)	...	...	x	x	x	...	...	x	...
„ *Nilssoni* (Barr)	x	x	x	...	...	...	...	x	x
„ (v.) *minor* (Nich.)	x	...	x	...	...	...	...	x	x
„ *lobiferus* (M'Coy)	x	x	x	...	...	...	...	x	x
„ *exiguus* (Nich.)	...	...	x	x	x	...	...	x	...
„ *priodon* (Bronn)	...	x	x	x	x	x	x	x	...
„ *colonus* (Barr)	...	...	x	x	x	?	x	x	...
„ *sagittarius* (His.)	x	x	x	x	...	...	?	x	x
„ *Griestoniensis* (Nic.)	...	...	...	...	?	...	x	...	...
„ *turriculatus* (Barr)	...	...	x	x	x	...	...	x	...
Retiolites perlatus (Nich.)	...	...	...	...	x	...	...	x	x
„ sp.	...	...	...	...	x	...	...	...	...
„ *Geinitzianus* (Barr)	...	...	?	...	...	...	x	x	...
Dictyonema, sp.	...	...	x	...	...	...	...	...	...
Protovirgularia Harknessi (Lap.)	...	...	...	...	x	x	..	...	...
Trichoides ambiguus (Hark.)	...	...	...	...	x	...	x	...	x
CRUSTACEA.									
Pterygotus, sp. (?)	...	...	x	...	x	...	...	...	...
Discinocaris Browniana (Woodw.)	...	...	x	...	x	...	x	...	x
Peltocaris aptychoides (Salt.)	...	...	x	x	...	...	...	...	x
Ceratiocaris, sp.	...	...	x	x	x	...	...	...	...
„ large sp.	...	...	...	...	x	...	...	...	...
ANNELIDA.									
Crossopodia Scotica (M'Coy)	...	...	...	...	x	x	...	...	x
Nereites Cambrensis (Murch.)	...	...	...	...	x	x	...	...	x
Nemertites tenuis (M'Coy)	...	...	...	...	x	...	x	...	...
„ sp.	...	...	...	...	x	...	...	...	...
Siphonotreta micula (M'Coy)	x	...	...	...	...	...	...	...	x
POLYZOA.									
Fenestella assimilis ?	...	...	x	x	x	...	...	x	...
Coral, sp.	...	...	x	x	...	...	...	...	...
Stromatopora striatella (?)	...	...	x	x	x	...	x	...	...
Protichnites, sp.	...	...	...	...	x	...	...	...	...
Tracks of swimming Crustacea, etc.	...	...	...	...	x	...	...	...	...
Orthoceras, sp.	...	...	x	...	...	...	...	...	...

Of the various species named in the above list, *Crossopodia Scotica*, *Nereites Cambrensis*, and that peculiar fossil *Trichoides ambiguus*, have all been discovered in the Moffat country, in the quarry at Hunterbeck; but, if Professor Harkness be correct in ascribing the repetition of the Anthracitic shales to great parallel faults, these beds may form part of the Gala series.

The presence of *Peltocaris aptychoides* and *Discinocaris Browniana* indicate a proximity to the Moffat beds, but the evidence they afford is more than counterbalanced by the presence of *Ceratiocaris* and other allied Caradoc forms.

Protovirgularia Harknessi and the *Eurypterus* are peculiar to the Gala Group, and of no value in fixing its age, and thus we are driven to depend upon the well-marked set of Graptolitidæ for more certain evidence. Fortunately, this is very decided, and, taking this as our main guide, we notice the following facts:—

1st. That there are two distinct and characteristic faunas in the district, the one peculiar to the Black Shale, the other to the Gala Group.

Of the thirteen fossils tabled above as being found in the shales, every one belong to the Moffat beds, and three are peculiar to that formation (*C. capillaris*, *R. maximus*, and *S. micula*), having never yet been found in the Caradoc.

Above the dark shales all are Coniston Graptolites, and at least four have never yet been found below the equivalent of the Bala Limestone.

The foliaceous species of Graptolites constitute more than a third of the fauna of the shales. Above the Anthracitic schists, on the contrary (if we except the small form of the Buckholm beds), all are mono-prionidian. This is, I know, but negative evidence; but the same seems to obtain in Cumberland also, where none of the Diplograpsi survive even into the higher Coniston flags. This phenomenon may, of course, be due to conditions of sea-bottom, and can at furthest be merely local, as both forms of the Graptolites expire together in Barrande's Upper Silurian; yet the circumstance is very noteworthy, and may serve here or in England to distinguish between the higher and lower beds of the series.

2nd. The upper fauna is pre-eminently of the Coniston or Bala type.

In the Abbotsford Flag, for the first time in the age of the Lower Silurian of Scotland, do we meet with *G. priodon*, a fossil that has never yet been detected below the Caradoc, proving at once that we are in a superior division to that of the Moffat series. *G. colonus*, a Lower Ludlow fossil in Siluria, soon becomes associated with it, and the two run together to the summit of the series, as in the Coniston Group, proving the unity of the whole deposit. To these that pretty little fossil, *G. turriculatus*, is soon added. This has only been found in Britain in the Coniston Flag, and is one of the many forms added to the British *Graptolitidæ* by Dr. Nicholson; and, lastly, we have *Retiolites Geinitzianus*, an Upper Silurian fossil of the Pentlands and Siluria, till the researches of Professor Harkness and Dr. Nicholson placed the Cumberland beds in the Upper Caradoc.

Thus we have four forms in the Gala Group which have never been detected below the Bala beds, and are peculiar to the Caradoc, or found only in that or higher deposits.

Professor Sedgwick and the Geological Survey of England place the Coniston beds in the Upper Silurian; but, even should this turn out to be the correct theory, it will merely clench the evidence before adduced to show that the Gala beds must be high in the Lower Silurian, and will strengthen the probability of their forming part of the Caradoc.

A careful comparison of the list of Moffat fossils given by Mr. Hopkinson in the GEOLOGICAL MAGAZINE for Feb., 1870, shows the clear separation of the Moffat and Gala Series. Of the 41 Graptolites in Hopkinson's list, 8 (*i.e.*, *Didymograpsi*, *Cladograpsi*, *D. pristiniformis*, *mucronatus*, and *C. bicornis*) are peculiar Llandeilo forms, while only 16 of the Graptolites of Moffat are found in the Coniston Group—or, in other words, one-third of the Graptolites of Moffat found elsewhere in Britain are peculiar to the Llandeilo. On the other hand, of the 12 known species of Graptolites given above as being found in the Gala Group, 4 only are common to the Gala and Moffat beds, the whole 12 have been found in the Coniston series, and 4 have never been found below the Caradoc, while every one is an Upper Silurian form in Bohemia.

From the description of the rocks given in the foregoing pages, and the list of fossils given above, it is plain that the whole set of beds considered as the Gala Group belong to one and the same formation, even if they be properly separable into subordinate divisions, as they seem to be in this district. The constant repetition of greywackes and shales, with alternating bands of flag or tiley strata, all bearing a remarkable similarity, renders it next to impossible to distinguish the position of any given bed here; and where the conditions of the sea bottom were different, as they were necessarily in an increasing ratio as we depart from the typical area, the deposits must have taken place under altogether different conditions, and the chances are that these divisions will be no longer recognizable lithologically, and we shall be driven to depend upon fossil evidence alone. But here the difficulty is increased, and the very facts that prove so conclusively the unity of the formation, militate against our attempt to distinguish its different beds. From the Abbotsford Greywackes to the summit of the Grieston Slates not a single new Graptolite seems to make its appearance, and hardly a fossil appears to have died out, though a change in the character of the sea bottom has introduced a swarm of Annelides and those fossils found in the mud of shallow seas. Hence, in effect, the Gala Group may collectively be considered as a thick and almost inseparable series of greywackes and shales, superior to the Moffat Series, and of Caradoc age. The Gala Group is plainly recognizable from the description given by Mr. Geikie (Mem. Geol. Surv., sheet 34), as being present in the troughs of the strata along the Berwickshire coast, where it has been rightly considered by him as of Caradoc age. It is seen again along the valley of the Dye water (Mem. Geol. Surv., sheet

33). The description of the section in this highly-perplexing district shows a remarkable similarity lithologically between the beds of the Lammermuirs and those of Gala. It seems to be present also in the cuttings of the Caledonian Railway above Moffat, and the rise of the sea bottom, in the upper part of the series, seems even to have extended to Barlae.

From a consideration of all these facts I am of opinion

1st. That the Gala Group forms a well-marked continuous subdivision of the Lower Silurian of Scotland.

2nd. That it is immediately superior to the Moffat schists in the order of these Lower Silurians.

3rd. That, in virtue of this position, and by its peculiar fauna, it is proved to represent part of the Caradoc formation of Siluria.

I have gratefully to acknowledge repeated encouragement and help from Dr. Page and Mr. D. J. Brown, and also the obligations I am under to Dr. H. A. Nicholson, for assistance, not only from his published writings, but also in personal correspondence.

NOTICES OF MEMOIRS.

ON THE MODE OF ACCUMULATION OF THE DRIFT-DEPOSITS OF THE WEST RIDING OF YORKSHIRE.[1] By D. MACKINTOSH, F.G.S.

After describing the general characteristics of the Drift-deposits, Mr. Mackintosh gave a minute account of about forty sections which he had examined during the previous six months. Upon the varied phenomena presented by these sections he founded his explanations of the derivation and mode of accumulation of the Drifts. He described the deposits in ascending order, and first the "Greyish Blue Clay." This has a very uniform character. The greater part of it is evidently crushed or washed shale and broken limestone. At least seven-eighths of it would appear to have been manufactured out of what may be called the raw shale and limestone of the plain of Craven and ramifying valleys. It must have been principally derived from the Lower Yoredale and Upper Limestone Shales. The boulders would appear to have come chiefly from the low-lying limestones of the Craven district. Most of the stones found in this clay are much rounded, as if they had been rolled, and not merely rubbed on one side. Ordinary wave-action on a sea beach would appear to have been a principal cause of their attrition. Comparatively few of them are uniformly striated. The scratches run *all round* the stones, and the small grooves cross each other at all angles. The striations, along with the polished surfaces exhibited by these stones, can be easily explained by the irregular and repeated action of coast-ice. To coast-ice, laden with boulders, stones, and debris, and floating on the surface of oceanic currents, we may likewise attribute the distribution of the coarser part of the deposit, which presents the appearance of having been successively dropped down on a sea-bottom. Above and around the more stony accumulations, we often find a considerable thickness of rudely-stratified clay, with few or no stones, which may have been assorted by the ordinary action of the sea. The idea that the "blue clay" was deposited after the extreme rigour of the glacial climate had passed away, accords with the opinion of Mr. Searles V. Wood, Jun., that the drifts of the North-west of England are newer than those of the South-east. A rather shallow sea, as the land was gradually sinking, and a sea acting principally between about 300 and 600 feet above the present sea-level, would appear to have been the main cause of the distribution of the "blue clay." This sea could not have been much indebted to land-ice sliding down the hill-sides or along the valleys, for such ice would have brought down a supply of materials different from those composing the "blue clay." For the underlying rock and the rock forming the slopes and summits of the hills above it, for great distances, is often Millstone-grit. We are therefore driven to the conclusion that the ice which undoubtedly had a share in shaping the stones and boulders found in the "blue clay" was sea-ice, coast-ice, or ground-ice. Patches of a dark clay, probably of the same age, with a greater or less per centage of limestone boulders, may be found in the Wharfe valley; near Ripon; around Leeds; filling up abrupt hollows between Wakefield and Doncaster, in a railway cutting near Royston, &c.

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[1] Read before the West Riding Geological and Polytechnic Society, at their meeting held in Sheffield, 29th of April, Lord Wharncliffe in the chair.

The Yellowish-brown and Variegated Clay.—It is not difficult to understand that after the land had subsided beneath the level which cut off the low-lying source of supply of the "blue clay," the shales and sandstones of the upper Yoredale and Millstone-grit formations composing the sides of the valleys and table-lands, would furnish materials for the "yellowish-brown clay" with its boulders. This clay extends from the bottom of the valleys up to the highest summits of the moors. It contains very little limestone, generally speaking; and that little, from the positions in which it is found, would appear to have been floated by ice. Nine-tenths of the "yellow clay" formation is local, and must have been principally washed out of the hill-sides where it is found. At the bottoms of the valleys, as at Bingley, it graduates into well rounded boulder-gravel. During the accumulation of this Drift, the table-lands and moors must have been completely submerged.

Stratified Sand and Washed Gravel.—The "blue clay" would appear to have undergone a certain amount of denudation before the "yellow clay" was thrown down above it, as its surface is generally uneven, and apparently eroded. The yellow clay presents indications of its having been denuded before the deposition of the sand and gravel. A part of the sand may have been derived from the "yellow clay," which is often more or less arenaceous, and apart from the direct denudation of the local Carboniferous grits and sandstones. The sand seldom rises higher than about 350 or 400 feet above the present level of the sea. In the Aire valley, it is evidently of the same age as the great sand formation of the vale of York, though in the vale of York the distinction between the sand and stratified gravel is generally better defined. Both the sand and washed gravel contain boulders, and from their position it is evident that they must have been dropped in. The action of floating ice, therefore, could not have ceased during the deposition of the sand. During the deposition of the sand there would appear to have been rapid currents in a shallow sea. The deflected and eddying action of these currents in peculiar situations would be likely to leave an undulating surface, varied by abrupt eminences. But the undulations left by deposition must have been modified by contemporaneous or subsequent denudation; for on a very uneven surface of sand (a surface unconformable to its stratification) an *upper Boulder-clay* was deposited. It may either have been derived from the denudation of the yellow Boulder-clay, or from a direct denudation of shale and rock; and it is difficult to explain its position above the sand, without supposing a slight reversion in the movement of the land, or a second partial subsidence.

Limits of River-Action.—Since the Glacial submergence, rivers have been occupied in cutting well-defined channels in drift-deposits. In most parts of the valley of the Aire they have not yet got down to the solid rock, and there is reason to believe that between Bingley and Skipton the drift in some places fills up hollows which at one time may have been lake-basins. The river-deposits consist of small pebbles, never spread out continuously for great distances, but confined to patches or ridges, and of a nearly stoneless sand and loam deposited over considerable areas. The rivers are not giving rise to boulder-deposits, or, with a few exceptions, to original drifts of any kind. A little investigation will show that where patches of pebbles are found in the river-channels, they have generally been washed out of boulder-drifts in the immediate neighbourhood.

REVIEWS.

I.—FLINT-CHIPS, a guide to Pre-historic Archæology, as illustrated by the Collection in the Blackmore Museum, Salisbury. By EDWARD T. STEVENS, Honorary Curator of the Blackmore Museum. 8vo., pp. 594. London: Bell and Daldy.

FEW men, however public-spirited, have shone out better than Mr. William Blackmore, the founder of the "Blackmore Museum," the contents of which have furnished the text and illustrations for the handsome and portly volume before us. Its author, Mr. Stevens, the Honorary Curator (who is also the brother-in-law of the Founder of the Museum), has been as ardent as Mr. Blackmore himself in carrying out the idea of founding a Pre-historic Museum in his native city, the birthplace of several generations of the Blackmore family.

Here, assembled under one roof, in a handsomely decorated room, with appropriate table and wall-cases, are exhibited in four great groups:—

I. Remains of Animals found associated with the works of Man.
II. Implements of stone.
III. Implements of bronze.
IV. Implements, weapons, and ornaments of Modern Savages, which serve to throw light upon the use of similar objects belonging to pre-historic times.

Under the first division Dr. H. P. Blackmore gives us a clear account of the Mammalian remains found in the "Drift Series" preserved in the Museum. To this is added the land, freshwater, and marine shells from the valley of the Somme, France; and next come the Mammalia from the Caves.

Mr. Stevens then proceeds to describe, in order due, the collection of the Stone age, dividing them into Palæolithic and Neolithic groups, according to Sir John Lubbock's classification.

Under the first we find the Drift implements from the Somme and Poitou in France, from the Norfolk and Suffolk valleys, from Bedford, Salisbury, and numberless other localities in England.

Many good types of each form are exhibited in the cases, and near them are placed the implements in use among modern savages, in order to explain the manner in which they were used, and the mode of "hafting" or fixing them in their handles.

Short accounts of the several caves from which remains have been procured for the Museum are given, each in its appropriate place.

From the Palæolithic we pass to the Neolithic period. The ancient pit dwellings near Salisbury, which the author compares to the *Souterrains* in the department of Tarn, Garonne, Loire, etc., in France, have also their analogues in the underground Post-houses in certain parts of Russia infested by mosquitos.[1]

The modern use of stone tools, in felling trees, making canoes, and all the numberless requirements of the hunter and fisher state, furnish matter of the greatest interest, as does also the methods of making flint and stone implements, as practised by the various tribes of Indians and other aborigines in modern times.

From the stone implements we pass pleasantly along—with Mr. Stevens for our guide—to the Ancient Lake Dwellings of Italy and Switzerland. the Shell-mounds of Denmark; then to North America, the West Indies, Central America, Mexico; each series of objects from each different region being appropriately illustrated by quotations and extracts from the best authorities, who have written upon the several countries and remains described; the author being in every case credited with each quotation.

No subject treated of by Mr. Stevens affords matter of greater interest to the geologist than that of the general distribution of stone implements throughout the world, showing that every country and people have, either in modern or prehistoric times, passed through the barbaric palæolithic and neolithic stages, and that no nation has—so far as we are aware—arrived at the bronze or iron age save by gradual advancement in the ruder and simpler arts of savage life.

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[1] See Mr. Lord's account in "Illustrated Travels."

The absence of metals in one region may have effectually checked their use, whilst in another they may have been discovered and worked from a very remote antiquity.

Viewed by the light afforded by such a collection as that contained in the Blackmore Museum—so ably and industriously illustrated and described by its Honorary Curator in the work before us—we are more strongly than ever impressed by the necessity of asking for greatly increased grants of time in order that the distribution and development of the human race should take place—as we know it must have done—very gradually, especially the earlier stages, such as this book is intended to illustrate.

A copious index is given, and the objects treated of are rendered even clearer still by the addition of 125 illustrations distributed through the text, and also by a plate of flint implements from Honduras, certainly the most remarkable heretofore seen.

The illustrations by Mr. G. R. De Wilde, are executed with great care and fidelity.

II.—GEOLOGICAL MAP OF LONDON, SHOWING SUPERFICIAL DEPOSITS.

Compiled by J. B. JORDAN, Esq., of the Mining Record Office, from the Published Maps and Memoirs of the Geological Survey of England and Wales, and from the Maps and Memoir accompanying "Reports of the Medical Officer of the Privy Council, 1866 to 1867," by R. W. MYLNE, Esq., and W. WHITAKER, Esq., B.A. Scale, one inch to a mile. London: E. Stanford.

THE compiler of this map has been diligent in the library, and has shown great aptitude in the performance of certain processes of digestion and assimilation. Is it possible that the mere consultation of the "Reports of the Medical Officer of the Privy Council" can have enabled him thus to triumph over the toughness of food utterly raw—entirely uncooked? Our own sad experience would have led us to predict a violent attack of dyspepsia, and our "Medical Officer" would have advised a walk into, let us say, that great north-western region which is so monotonously depicted as "a stiff blue clay impervious to water." In the interests of the purchasers of this map, we are led to exclaim, Would that Mr. Jordan were dyspeptic! Just one "Journey due North" would have imbued him with a wholesome scepticism, and would probably have led to the publication of a map which might more justly lay claim to the title of a "Geological Map of London, showing superficial deposits."

REPORTS AND PROCEEDINGS.

Geological Society of London.—April 27th, 1870.—R. A. C. Godwin-Austen, Esq., F.R.S., Vice-President, in the Chair. The following communications were read:—1. "On the Species of Rhinoceros whose remains were discovered in a Fissure-cavern at Oreston in 1816." By George Busk, Esq., F.R.S., F.G.S.

The object of this paper was to show that the Rhinoceros, whose remains were discovered by Mr. Whidbey in a fissure-cavern at Oreston, near Plymouth, in the year 1816, and described by Sir Everard Home in the "Philosophical Transactions" for 1817, belonged, not, as has hitherto been supposed by every one except the late Dr. Falconer, to *Rhinoceros tichorhinus*, but to *Rh. leptorhinus*, Cuv. (*R. megarhinus*, Christol).

The remains in question are in the Museum of the Royal College of Surgeons, and consist of between thirty and forty more or less broken portions of the teeth and of numerous bones of the skeleton. The greater number being hardly in a condition to afford satisfactory diagnostic specific characters, the remarks in the paper were limited to the teeth and to a perfect metacarpal bone, which appeared amply sufficient for the purpose.

The teeth mainly relied upon were the first or second upper molars (m^1 or m^2) of the right and left sides. Both the teeth were broken, but what was wanting in one was supplied by the other. The characters exhibited were shown to be unlike those of *R. tichorhinus*, and quite in accordance with those of *R. leptorhinus*. These were the thinness and smoothness of the enamel, the configuration of the dorsal surface, the form and size of the columns, and the disposition and relations of the "uncus" and "*pecten*" ("*crochet*" and "anterior combing-plate;") and the consequent absence of the characteristic "*tichorhine pit*" or *fossette*. The less strongly marked characters by which the teeth could be distinguished from those of *R. hemitæchus*, Falc., and *R. etruscus*, Falc., were also pointed out.

The metacarpal bone selected for the illustration of the diagnosis is 9¼ inches long, and remarkable for the compression of the shaft, and its comparative slenderness, as contrasted with the same bone in *R. tichorhinus*, specimens of which were exhibited on the table, and which, in no case within the author's knowledge, ever exceeds 7½ or 8 inches in length, and is proportionately much thicker than in *R. leptorhinus* or any other extinct species. The size and form of the bone also showed that the species could not be either *R. hemitæchus* or *R. etruscus*, for although the means of direct comparison with the third metacarpal of those species did not, to the author's knowledge, exist in London, its probable general dimensions and proportions could be deduced from those of the corresponding metatarsal, of which bone numerous specimens were available. It was further shown that the Oreston metacarpal exactly corresponded with those of *R. leptorhinus*, from Grays Thurrock, in the British Museum.

The determination of the species appears to be of considerable interest, inasmuch as it affords an additional instance of the occurrence in England of the great southern Rhinoceros. This is also the only example of the discovery of that species, except in river or other deposits, either in this country or on the continent.

Discussion.—The Chairman remarked that at one time the Oreston *Rhinoceros* was referred to *R. tichorhinus*, but that Buckland, although mentioning the *Rhinoceros*, never gave it a specific name. The Chairman also said that the Oreston fissures were not caves, but mere fissures which had been filled in; an entire skeleton occurred at one spot, and the animal must have fallen in.

Mr. Boyd Dawkins had been struck by the non-tichorhine character of the Oreston specimens some years since. He confirmed Prof. Busk's determination, and remarked that five British species of *Rhinoceros* are known, namely: 1. *R. Schleiermacheri*, from the Red Crag of Suffolk (in the Miocene at Darmstadt); 2. *R. etruscus*, from the Forest Bed = *R. Merckii* (Von Meyer); 3. *R. megarhinus* (Christol) = *leptorhinus* (Cuv.); but the latter name includes also *R. Etruscus* and *R. hemitœchus*; so that the adoption of De Christol's name gets rid of a difficulty; 4. *R. hemitœchus*; and 5. *R. tichorhinus* = *R. antiquitatis* (Blum.).

Prof. Busk, in reply, stated that Oreston was a fissure-cavern, and noticed the successive openings in 1816, 1821, and 1826. He did not agree with Mr. Boyd Dawkins in preferring the name *megarhinus* to Cuvier's *leptorhinus*. He did not know of the occurrence of two species of *Rhinoceros* at Oreston.

2. "On two Gneissoid series in Nova Scotia and new Brunswick, supposed to be the equivalents of the Huronian (Cambrian) and Laurentian." By H. Youle Hind, Esq., M.A. Communicated by Prof. Ramsay, F.R.S., F.G.S.

This paper described the relations of two gneissoid series in Nova Scotia and New Brunswick, which have hitherto been regarded as intrusive granites and syenites, and have been thus represented on the published geological maps of those provinces. The author considered that these gneisses were in the main of Laurentian age, the Huronian or Cambrian rocks occurring only in patches over a vast area of Laurentian porphyroid gneiss.

The old gneiss was stated to be brought to the surface by three great undulations between the Atlantic coast of Nova Scotia and the Laurentian axis of America north of the St. Lawrence. These axes were rudely parallel to one another, and in the troughs which lay between them the Silurian, Devonian, and Carboniferous series occurred in regular sequence, the New Brunswick Coal-field occupying the central trough. On the line of section, in the troughs to the north-west and south-east, the Lower Carboniferous was stated to be the highest rock series which has escaped denudation.

The gold-bearing rocks of Nova Scotia are of Lower Silurian age, and rest either on Huronian strata, or, where these had been removed by denudation, on the old Laurentian gneiss. The gold is found chiefly in beds of auriferous quartz of contemporaneous age with the slates and quartzites composing the mass of the series, which, in Nova Scotia, is 12,000 feet thick; and the auriferous beds are worked, in one district or another, through a vertical space of 6000 feet. Besides auriferous beds of quartz, intercalated beds and true veins are found to yield gold, and are worked.

A series of sharp and well-defined anticlinals ridge the province of Nova Scotia from east to west, while another series of low broad anticlinals of much later date have a meridional course. At the intersection of these anticlinals the gold districts are situated, because there denudation has best exposed the upturned edges of the auriferous beds of quartz, and rendered them accessible, sometimes exposing also the underlying gneiss. Plans of Waverley and Sherbrooke gold districts were exhibited, showing the outcrop of the edges of the slates and auriferous beds of quartz in semi-elliptical forms, with the gneiss at the base of the ellipse. On this ground it was suggested that a correct mapping of the gneisses of Nova Scotia would have an important influence on the development of the mineral resources of the province.

A plan of some of the lodes in the Waverley gold district showed the result of operations in 1869, subsequently to the publication of a geological map and sections of the district furnished to the Department of Mines by the author in 1868. Citations were made from the annual reports just issued by the Chief Commissioner of Mines and of the Inspector of Mines, confirming the correctness of the author's plans exhibiting the geological structure of Waverley, which is a type of all the Nova Scotian gold districts.

Discussion.—Principal Dawson spoke in confirmation of the fact that the Palæozoic rocks are underlain by Laurentian gneiss, &c., quite to the eastern coast of British North America, and stated that the same relation occurred in Newfoundland, and had been traced southwards into Massachusetts. He confirmed Mr. Hind's views generally, and stated that the Lower Silurian of Nova Scotia includes no great fossiliferous limestone, like that of the interior of North America. The supposed *Eozoon*, discovered by Dr. Honeyman, was probably distinct from *E. canadense*, but was certainly a Foraminiferal organism allied to *Eozoon*; but as *Eozoon bohemicum* is of later date than *E. canadense*, the presence of *Eozoon* did not necessarily indicate Laurentian age.

Prof. Ramsay suggested that other organisms besides *Eozoon* aided in building up these great calcareous masses. He inquired as to the mode of occurrence of gold, and suggested that the gold is obtained at the anticlinals merely because the exposure is better, and that it will be found to pervade the synclinals also.

Mr. Henry Robinson had visited the Waverley district in company with Prof. Hind, in the winter of 1868, at which time the mining on the lodes referred to in the map before the Society was at a standstill, the lodes having been lost by reason of a fault. He thought it was very satisfactory to find that the explorations of Prof. Hind, and the theoretical position which he assigned to the lodes, had been completely verified. Mr. Robinson also stated that gold is being mined in the synclinals by sinking shafts and driving cross-cuts.

Mr. Hind remarked that all the Lower Silurian in Nova Scotia was auriferous, and that the gold was derived from the underlying Laurentian rocks. He stated that Sir W. E. Logan had indicated an auriferous zone in the Laurentian of Canada. Gold was finely distributed in the slates of Nova Scotia, as in Victoria, in the neighbourhood of lodes, according to Mr. R. Brough Smyth.

Geological Society of London.—II. May 11, 1870.—Joseph Prestwich, Esq., F.R.S., President, in the Chair. The following communications were read:—1. "Notes on some specimens of Lower-Silurian Trilobites." By E. Billings, Esq., F.G.S., Palæontologist of the Geological Survey of Canada.

(1) The author first described a specimen of *Asaphus platycephalus*, in which the hypostome was not only preserved *in situ*, but also the remains (more or less well preserved) of eight pairs of legs,

corresponding with the eight segments of the thorax, to the underside of which they had been attached. The appendages take their rise close to the central axis of each segment, and all curve forwards, and are thus most probably ambulatory rather than natatory feet. They appear to have had four or five articulations in each leg.

Three small ovate tubercles on the pygidium may perhaps indicate the processes by which the respiratory feet were attached.

Mr. Billings referred to the large number of Trilobites which have been examined, and expressed his belief that only the most perfectly preserved specimens are likely to have the organs on the underside preserved.

(2) Mr. Billings next described the doublure or pleura in the Trilobites, comparing it to that of *Limulus*. He then proceeded to describe a row of small scars and tubercles on the underside of the pleuræ, to which both Dr. Volborth and Dr. Eichwald believed soft swimming feet or hard horny legs had been attached. As these were first seen by Dr. Pander in a Russian Trilobite, Mr. Billings has called them "Panderian organs." He thinks soft natatory appendages may have been attached to these scars.

(3) Mr. Billings directed attention to the *Protichnites* and *Climactichnites*, which he thinks may now be safely considered to be the markings left by *Crustacea*, belonging to the division *Trilobita*.

(4) Finally, Mr. Billings described a section of a rolled-up *Calymene senaria*, the interior cavity of which appears to be full of minute ovate bodies, from 1-80th to 1-100th of an inch in diameter. These small ovate bodies the author believes to be eggs.

2. "Note on the palpus and other appendages of *Asaphus*, from the Trenton Limestone, in the British Museum." By Henry Woodward, Esq., F.G.S., F.Z.S.

Mr. Woodward, when comparing the Trilobite sent over by Mr. Billings with specimens in the British Museum, presented by Dr. J. J. Bigsby, F.R.S., discovered, upon the eroded upper surface of one of these, not only the hypostome exposed to view, but also three pairs of appendages, and what he believes to be the palpus of one of the maxillæ. This furnishes an additional fact to Mr. Billings's most interesting discovery, besides confirming its correctness.

Mr. Woodward considers the so-called "Panderian organs" to be only the fulcral points upon which the pleuræ move, and showed that such structures exist in most recent Crustacea.

He considered that the evidence tended to place the Trilobita near to, if not in, the Isopoda Normalia.

He remarked that the prominence of the hypostome reminded one strongly of that organ in *Apus*, and suggested that we might fairly expect to find that the Trilobita represented a more generalized type of structure than their representatives at the present day, the modern Isopoda.

Discussion.—Mr. Woodward had carefully examined Mr. Billings's specimen, and agreed with him in considering that there was undoubted evidence of the presence of walking-appendages under the thorax. The presence of such limbs might d *priori* have been expected; and the nature of the test suggested that the Trilobites were walking rather than swimming forms of Isopods. The branchiæ had probably been under the telson; and this would account for its large development. It was not more surprising to find highly organized Trilobites than it was to find such highly organized crustaceans as *Pterygotus*, *Eurypterus*, and *Slimonia* in the same beds.

Prof. Rupert Jones, Principal Dawson, and Sir William Logan made some remarks, more especially on Protichnites and Climactichnites, the latter having been explained as galleries of Crustacea by Prof. Jones, when first exhibited in England.

3. "On the Structure and Affinities of *Sigillaria*, *Calamites*, and *Calamodendron*." By J. W. Dawson, LL.D., F.R.S., F.G.S., Principal and Vice-Chancellor of M'Gill University, Montreal.

The object of this paper was to illustrate the structure and affinities of the genera above named, more especially with reference to the author's previous papers on the "Structures in Coal," and the "Conditions of Accumulation of Coal," and to furnish new facts and conclusions as to the affinities of these plants.

With reference to *Sigillaria*, a remarkably perfect specimen of the axis of a plant of this genus, from the Coal-field of Nova Scotia, was described as having a traversely laminated pith of the *Sternbergia* type, a cylinder of woody tissue, scalariform internally, and reticulated or discigerous externally, the tissues much resembling those of Cycads. Medullary rays were apparent in this cylinder; and it was traversed by obliquely radiating bundles of scalariform vessels or fibres proceeding to the leaves. Other specimens were adduced to show that the species having this kind of axis had a thick outer bark of elongated or prosenchymatous cells. The author stated that Prof. Williamson had enabled him to examine stems found in the Lancashire Coal-field, of the type of Binney's *Sigillaria vascularis*, which differed in some important points of structure from his specimens; and that another specimen, externally marked like *Sigillaria*, had been shown by Mr. Carruthers to be more akin to *Lepidodendron* in structure. These specimens, as well as the *Sigillaria elegans*, illustrated by Brongniart, probably represented other types of Sigillarioid trees, and it is not improbable that the genus *Sigillaria*, as usually understood, really includes several distinct generic forms. The author had recognized six generic forms in a previous paper, and in his "Acadian Geology;" but the type described in the present paper was that which appeared to predominate in the fossil Sigillarian forests of Nova Scotia, and also in the mineral charcoal of the coal-beds. This was illustrated by descriptions of structures occurring in erect and prostrate *Sigillariæ*, on the surface of *Sternbergia*-casts, and in the coal itself.

The erect *Calamites* of the coal formation of Nova Scotia illustrate in a remarkable manner the exterior surface of the stems of these plants, their foliage, their rhizomata, their roots, and their habit of growth. Their affinities were evidently with Equisetaceæ, as Brongniart and others had maintained, and as Carruthers and Schimper had recently illustrated. The internal structure of these plants, as shown by some specimens collected by Mr. Butterworth, of Manchester, and soon to be published by Prof. Williamson, showed that the stems were more advanced in structure than those of modern *Equiseta*, and enabled the author to explain the various appearances presented by these plants, when the external surface is preserved, wholly or in part, and when a cast of the internal cavity alone remains. It was further shown that the leaves of the ordinary Calamites are linear, angular, and transversely wrinkled, and different from those of the *Asterophyllites* properly so called, though some species, as *A. comosus*, Lindley, are leaves of Calamites.

The Calamodendra, as described by Cotta, Binney, and others, and further illustrated by specimens from Nova Scotia, and by several interesting and undescribed forms in the collection of Prof. Williamson, are similar in general plan of structure to the *Calamites*, but much more woody plants; and, if allied to Equisetaceæ, are greatly more advanced in the structure of the stem than the modern representatives of that order. Specimens in the collection of Prof. Williamson show forms intermediate between *Calamites* and *Calamodendron*, so that possibly both may be included in one family; but much further information on this subject is required. The tissues of the higher *Calamodendra* are similar to those of Gymnospermous plants. The wood or vascular matter of the thin-walled Calamites consists of multiporous cells or vessels, in such species as have been examined.

In conclusion, a Table was exhibited showing the affinities of *Sigillariæ* on the one hand, through *Clathraria* and *Syringodendron* with Lycopodiaceæ; and on the other hand, through *Calamodendron* with Equisetaceæ; while in the other direction they presented links of connexion with Cycads and Conifers.

Discussion.—Mr. Carruthers expressed his thanks for the amount of information given by Dr. Dawson, but was inclined to take a somewhat different view on some of the points mentioned. Some time ago he had, in a paper read to the Society, deduced from the internal structure of *Stigmaria*, the root of *Sigillaria*, that the latter was a true cryptogamous plant. He had since met with confirmatory evidence, in a specimen of a fluted and ribbed *Sigillaria*, showing the internal structure of *Stigmaria*. Mr. Baily, in Devonian strata in Ireland, had found the root, stem, branches, leaves, and fruit of a plant which could, with certainty, be correlated. The root was a *Stigmaria*, the stem a fluted *Sigillaria*, the branches and leaves like those of *Lepidodendron*, and the fruit that of a cryptogam, allied to *Lepidodendron*. With regard to the American specimens cited by the author, he would not speak with certainty; but he might suggest a different interpretation. The axis was probably foreign to the *Sigillaria* in which is was found, and was a true coniferous stem composed of pith, medullary sheath, and wood with medullary rays, and vascular bundles passing to the leaves. Plants growing in the interior of decayed sigillarian stems had been mistaken for organic piths, though they belonged to two or three genera. Dr. Dawson's estimate of *Calamites* and allied genera essentially agreed with those which he held.

Dr. Dawson thought that the views of Mr. Carruthers and his own might possibly be reconciled, but was not prepared to admit that the plant discovered by Mr. Baily was a true *Sigillaria*. It belonged, moreover, to the Devonian period, and not to the Carboniferous. He quite agreed with Mr. Carruthers in regarding the stems as closely allied to gymnosperms. He insisted on the layer at the base of the interior of the trunks of the erect *Sigillaria* affording evidence of the interior structure of the plant, inasmuch as it consisted of the compressed and decayed inner tissues of the tree. It was curious that similar specimens had not been found in England; but the structures of these plants certainly occur in the English coal, which, like that of

ova Scotia, rests on *Stigmaria*-underclays; and there were other instances of trees eing common in the Coal-measures of Nova Scotia which were extremely rare in ngland; and the same discrepancies were found between different American coal-elds.

4. "Notes on the Geology of Arisaig, Nova Scotia." By the Rev. . Honeyman, D.C.L., F.G.S.

The author referred to a previous paper on the Upper Silurian ocks of Nova Scotia, which he stated appeared to him now to be enerally repetitions of his Arisaig series. He noticed the occur-ence of fossils in one of the beds previously supposed to be almost estitute of organic remains, and described the occurrence, in Arisaig ownship, of a band of crystalline rocks which appeared to contain *ozoon* and which was probably of Laurentian age. A note from rof. Rupert Jones, giving an account of the fossils referred to by r. Honeyman, was also read.

DISCUSSION.—Sir W. Logan said that Dr. Hunt had seen the specimens of serentinuous limestone, and considered that they might be Laurentian. Sections of hem appeared to Dr. Dawson to show tubulation rather different from that found n Laurentian *Eozoon*. They might, therefore, belong to a different age.

EDINBURGH GEOLOGICAL SOCIETY.—At a meeting of this Society, eld on the 3rd of March (A. Geikie, Esq., F.R.S., &c., President, in he chair), the following communications were read :—I. Notes on he Geological Features of the Upper Coal Basin of the Firth of orth. By Henry Cadell, Esq.—The district embraced in the paper xtended from Blackness and Charleston on the east to Grangemouth nd Kincardine-on-Forth on the west. In that district, on the south f the Forth, there are indications that coal has been worked in it for everal centuries. Along the shore a number of beds of trap were een capping eminences, and generally dipping to the westward, and he author exhibited a section in which a seam of coal from eight to en feet thick had been burned out by the trap, and others were so njured as to be quite unworkable. On the north side of the Forth great many traces of old coal workings were found, which for the ast half century had been abandoned. The old quaint burgh of ulross was in former times a flourishing town from its coal mines nd salt works. His impression was that most of these trap beds ad been deposited as lava during the formation of the Coal-measures, lthough in some cases they may have been injected into the strata. ccompanying these beds of trap there is generally either above or elow a bed of what is called "culmstone," which is a white or ream-coloured, smooth, argillaceous stone. This appears to have een either fireclay or shale burnt by the trap, and frequently eneath these trap beds are one or more thin beds of intensely hard iliceous sandstone, which most probably has been indurated by the icinity of the trap. Of fossil remains, a few good specimens have een found in the sandstones and shales.—Mr. Geikie expressed the bligations of the society to Mr. Cadell for his paper, though he was isposed to disagree with him in reference to some of his remarks.

He specially noticed Mr. Cadell's observations with reference to the influence of the traps. His own feeling was that, especially as regarded the coals that underlay and were associated with the trap in the west part of the Charleston field, he could not think there was any evidence, although the coals were poor, that they had been altered or burned by the influence of these igneous masses. On the contrary, in a number of cases, especially in the sinking of one pit which he mentioned, they found a mass of coal lying in the very heart of some of these traps.—2. On the Lower Silurian Rocks of the neighbourhood of Galashiels; illustrated with typical specimens of the fossils found in these rocks. By Charles Lapworth, Esq.[1]

GLASGOW GEOLOGICAL SOCIETY. — I. Ordinary meeting, March 3rd; Edward Wünch, Esq., Vice-president, in the chair.

Mr. Thos. Barclay exhibited pieces of the branches of silicified palm trees, which he had collected for the society's museum during a recent visit to Lower Egypt. They were obtained in the neighbourhood of Cairo, where there exists the remains of an extensive forest, which during the Tertiary period had become submerged, and the vegetable matter having decomposed slowly, its substance had been replaced by silex, with which the waters had been charged. The specimens displayed the vegetable structure as perfectly as in the original plant.

Mr. John Young read a paper "On the occurrence of the remains of Carboniferous fishes in certain thin beds of indurated shale that lie between sheets of igneous trap, composing the Kilpatrick range of hills at Auchentorlie, near Bowling." His attention was first directed to this shale by the late Mr. Alexander Currie, of Bowling, and in one of its layers he had since discovered scales, teeth, and coprolites of at least two genera of Carboniferous fishes—*Palæoniscus* and *Amblypterus*. It crops out upon the hill-side, at an elevation of 600 feet above sea-level—being on nearly the same geological horizon, and lying between the same beds of trap as the seam of peaty coal and shale beds formerly discovered by Mr. Currie, and described by him in a paper published a few years ago in the Transactions of the society. Mr. Young referred to the satisfactory evidence afforded by the discovery of these coal and shale beds in clearly establishing the Carboniferous age of that long chain of Trappean hills which stretch along the north-western border of our coalfields from Ardrossan to near Stirling. Mr. Young also read a paper "On a supposed old river-channel, buried under recent drifts, extending from Kilsyth to the Clyde." Criticising Mr. Croll's paper, published in the Transactions of the Edinburgh Geological Society, (see GEOLOGICAL MAGAZINE for May, p. 233,) he confined his remarks to the western division of the basin, namely, that extending from Kilsyth to the Clyde, for the purpose of showing that this deep trough could not have been scooped out by river action, nor could it ave entered the Clyde at Bowling, and from thence downward coninuously to the sea at a depth of more than 200 feet below the resent sea-level. Mr. Croll, in assuming that this great deep rough, which extends along the course of the Kelvin valley, and lso up the valley of the Clyde to above Glasgow, was scooped out y river action, seems to have lost sight of the fact that on both ides of the river Clyde, extending from Erskine Ferry to below Bowling, the trap rock comes close to the shores of the river along his tract, narrowing and forming the comparatively shallow bed of he channel which the Clyde Trustees have been engaged deepening or years. This sunken trap ridge of Carboniferous age is a coninuation of that forming the Kilpatrick and Renfrewshire range of ills. Mr. Young next pointed out that this low ridge of rock would form a barrier across the Clyde valley at this point; and if, s Mr. Croll supposes, the land there stood 200 or 300 feet above the present sea-level, he (Mr. Young) could not see how the waters of he Clyde, into which the Kelvin, Cart, and other streams flow, could ever have reached the sea outside until they reached the height of the lowest portion of this rock-barrier at Bowling; nor could the sea, even at a later period, ever have obtained access into he upper reaches of the Clyde, eastward of the barrier, until his rocky ridge was depressed beneath the sea-level, which was probably during the Glacial period, and in which there is evidence, from the marine shells found at Paisley and elsewhere, hat marine conditions prevailed, in reaches of the Clyde eastward of the barrier, as far up the river as Glasgow. At present his barrier at Bowling has been reduced by erosion and man's agency to a depth of from twenty to thirty feet below the evel of the river, but it must be at least still 200 feet above the bottom of the deep rock basin which stretches eastward up the Clyde and Kelvin valleys, as revealed by the bores. Mr. Young howed that this rock-basin, previous to its being filled up by recent ediments, must have existed as a deep lake, whose waters stood on a evel with that of the barrier, just as the present barrier at the mouth of Loch Lomond determines the height of its waters above hat of the sea. Mr. Young further stated that a river flowing westward from the watershed at Kilsyth, along the valley of the Kelvin, would, supposing it could be cleared out of its present urface deposits, have only to run down a sloping channel to the depth of 100 feet, when it would have entered the great lake, whose bottom at many places was more than 300 feet below the level of he above watershed, and whose waters, while the land stood higher, would always be on the level of the barrier at Bowling.

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[1] This paper has appeared in the GEOLOGICAL MAGAZINE. See the Numbers for May and June of this year, pp. 204 and 279.

II. Ordinary meeting, April 14th.—Prof. J. Young, M.D., F.G.S., &c., President, in the chair.—Mr. J. Croll communicated a letter in eference to some remarks recently made by Mr. John Young on his paper, entitled, "On two river-channels buried under drift," &c. Mr. Young had stated that the deep hollow which he (Mr. Croll) had every reason to believe was the ancient bed of the Kelvin, was scertained by a bore at Drumry to be no less than 230 feet below the present sea level; and that for several miles to the east and west of this place it was nearly as deep. Consequently, if this hollow was an old river channel, it must enter the Clyde somewhere near to Bowling, at a depth, below the present sea level, of upwards of 200 feet, and, "if so, then it followed that the rocky bed of the ancient Clyde must be buried under more than 200 feet of surface deposits, from Bowling downwards to the sea." Nothing was inferred by Mr. Croll regarding what may have been the condition of the Clyde above Bowling, consequently Mr. Young's objections, grounded upon the supposition of a rocky barrier crossing the Clyde below Erskine Ferry, had absolutely nothing to do with the question at issue.

Mr. James Geikie, vice-President, then made a few remarks, stating that he had visited the localities mentioned in Mr. Croll's letter, and that he objected to some of Mr. Young's statements. It was not the case that trap-rock occurred in the bed of the Clyde at Erskine Ferry, neither did it come close to the shores of the river at this place so as to narrow the channel; and, as no rock was met with between this point and the sea, it was quite gratuitous to assume that the river flowed over a shallow rocky bed. Neither in bores nor in dredgings had anything save mud, sand, clay, and gravel been met with in the Channel of the Clyde, between Erskine Ferry and Bowling. The fact was that the hills only approached close to the river at Bowling, and even here there was sufficient room between the lip of the river and where the rock appeared on the southern shore for a broad river channel to be buried. Mr. Geikie had protracted the slopes of the hills at Bowling, and found that, by continuing the angle formed by the inclination of the hills on both sides, we could not have a less depth than from 250 feet to 280 feet of drift deposits lying in the centre of the valley at this place. This result fully bore out the conclusions arrived at by Mr. Croll in his paper. Mr. Geikie then went on to say that the only place where rock actually occurred in the bed of the Clyde was at Elderslie, near Renfrew Ferry. Mr. Deas, resident engineer to the Trustees of the Clyde Navigation, had kindly allowed him to inspect the charts and bores in his office, and from these it was apparent that at Elderslie the river flowed a short distance upon rock. This rock was part of a bed of dolerite intruded among sedimentary strata of Carboniferous limestone age, and Mr. Young was wrong in supposing that it belonged to the Trappean series of the Kilpatrick and Renfrewshire hills. The mere fact of rock crossing the river at Elderslie was no proof whatever for the existence of any such rocky barrier as that imagined by Mr. Young. The alluvial and drift deposits stretched far away to the south and north of Renfrew Ferry, and all over that broad haugh-land no rock appeared.

Mr. John Young, in reply, explained that the main point he wished in his former remarks to establish had been that Mr. Croll, in the map attached to his paper, made the channel of the Kelvin open into the Clyde at Bowling as a deep river gorge, whereas he (Mr. Young) contended that neither the Clyde nor Kelvin could have flowed continuously to the sea, through a deep gorge in the line of the indicated channel, at a depth of more than 230 feet below the present level of the sea. Mr. Geikie and Mr. Croll assert that there are no barriers of trap or other rock across the Clyde, above or at Bowling, which could shut in the waters of the Clyde and Kelvin so as to prevent them from getting to the sea at the depth abovementioned. Mr. Young said that he had made some inquiries of parties who know the ground intimately as to the nature of these barriers, and they assert that the first or highest barrier of trap goes right across the river at Elderslie. Mr. Young considered that Messrs. Croll and Geikie had failed to point out, either on the north or south side of the present channel, any deep rock-gorge sufficient to drain the old lake basin extending up the Kelvin and Clyde. Again, there is evidence for the borings put down below Paisley and this portion of the Clyde, where there is a large tract of comparatively level land, that the old lake bottom shallows somewhat rapidly in this direction. Indeed, he considered that if a buried river channel ever had any existence, it could not have been over the line of ground indicated by Mr. Croll.

Mr. D. Bell then read a paper entitled "Aspects of Clydesdale during the Glacial Period."

PROCEEDINGS OF THE YORKSHIRE NATURALISTS' CLUB, 1869.—In presenting their report for the year 1869, the Committee of the Yorkshire Naturalists' Club congratulate the members on the continued prosperity and increased activity of the club. The monthly meetings have been regularly held and generally well attended. Numerous specimens in various departments of natural history have been exhibited, and much valuable information has thereby been elicited, giving sufficient evidence of the zeal and assiduity displayed by some of our Yorkshire naturalists in the cultivation of those departments of science to which their attention is specially devoted. Moreover several interesting papers on geological subjects have been communicated, abstracts of which appear in the present Report.

Mr. E. Allen, F.G.S., read a paper on the Speeton Clay, pointing out its subdivisions, and exhibiting a series of fossils which he had obtained from the cliff section. He made some remarks on the coprolite and cement beds, below the Speeton Clay, both of which have been worked for upwards of thirty years. The coprolites consist of dark coloured, almost black stone, containing iron pyrites; samples that are free from clay are said to yield from 57 to 61 per cent. of phosphate of lime, which is used for agricultural purposes.

Mr. J. F. Walker, F.G.S., recorded his discovery of *Rhynchonella spinosa* in the Bradford clay, at Tetbury Road, near Cirencester. He also exhibited some *Rhynchonellæ* sent to him by the Rev. J. E. Cross, M.A., which are supposed to be an extreme variety of *R. spinosa*, from which they differ in their smaller size, in having fewer plaits on the surface of the valves, and by the greater distance of the plaits from each other, seldom having more than twelve plaits on each valve. They also appear to differ from *R. spinosa* in having a mesial fold of generally three plaits. The hardness of the rock makes it difficult to obtain perfect specimens, but in those which he exhibited the beak appears to be more incurved than in the typical specimens. He proposed the name of *R. Crossii* for this variety. The specimens were obtained from the inferior Oolite of Appleby, near Brigg, Lincolnshire.

The Rev. J. F. Blake, M.A., F.G.S., communicated a paper on the "Red Chalk," sketching out its geographical range. Its most southerly appearance is near Hunstanton; from thence it is traced through Lincolnshire to South Ferriby, crossing to the north of the Humber (Mr. Blake had seen it at Welton Dale); thence it skirts the base of the Chalk to Elloughton, then a little to the north of South Cave, and several times in the hills between there and North Newbald, and at Sancton; it is said to occur at Bishop Wilton, and onwards to Grimston, and thence with a change of strike by Knapton eastwards to Speeton. He remarked that the palæontological evidence was almost irresistible for its Green-sand age.

The Hon. Payan Dawnay was elected President of the Club for 1870, and as Vice-Presidents Mr. J. Leckenby, F.G.S., and Mr. E. Wood, F.G.S.

CORRESPONDENCE.

THE MINERAL-BEARING STRATA OF THE SOUTH-WEST OF IRELAND.

SIR,—In the Supplement to the GEOLOGICAL MAGAZINE for May, 1870, Mr. S. Hyde, writing on this subject, compares the mines on the Bear promontory with those on the Crookhaven and Sheep's-head promontories. To me, however, this does not seem to be a fair comparison, as Mr. Hyde, along with previous writers on the subject, neglects to mention one of the most important features in regard to the first-named locality, namely, the large development of ingenite rocks.

These rocks were intruded subsequent to the deposition of the "Coppery Zone" in the so-called Devonian rocks, and to the ingenite rock, I believe, is due the productiveness of the lodes at Allihies and thereabouts, while in the promontory of Crookhaven, where none of these ingenite rocks have been found, the lodes are, comparatively speaking, poor.

What seems to be in favour of this theory is the fact, that in most if not all the places where rocks of this age occur that have not been subsequently invaded by ingenite rocks, although minerals are common, they are not collected into the lode. but are disseminated through the beds, while in those places where the newer ingenite rocks now exist, the minerals principally occur in the lodes and are not disseminated through the rocks. This would account for the ores in lodes in Cornwall, Devon, Allihies, &c., while in other places, that apparently ought to be as good "ground," few or no paying lodes occur.

G. H. KINAHAN,
RECESS *viâ* GALWAY. H.M. Geological Survey of Ireland.

ERRATA.—In Prof. T. Rupert Jones's article last month we notice the following Errata: p. 217, line 17, *for* Fig. 1, *read* Fig. 3; p. 218, line 26, *for* sharper, *read* blunter; p. 218, line 37, *for* larger, *read* smaller.

John Phillips

THE

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ORIGINAL ARTICLES.

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EMINENT LIVING GEOLOGISTS.

I.—John Phillips, M.A., D.C.L. Oxon., LL.D. Cambridge and Dublin, F.R.S., etc., Professor of Geology in the University of Oxford.

(With a Portrait.)

JOHN PHILLIPS was born on the Christmas Day of 1800 (N. S.), at Marden, in Wiltshire. At this period the science of Geology, to which he has devoted himself so ardently, was itself struggling into active life. Men had talked of "Theories of the Earth," and with much fancy had built it up of concentric rings, but there were scarcely any actual observers of those strata of which they discoursed so poetically.

John Phillips's father was the youngest son of a Welsh family, settled for very many generations on their own property at Blaen-y-ddol, in Caermarthenshire. The elder Mr. Phillips was trained for the Church, in which some of his relations had place, but this plan was not carried out; he came to England, was appointed to an office in the excise, and married the sister of William Smith, of Churchill, in Oxfordshire, designated by Prof. Sedgwick "the father of geology,"[1] a title since universally adopted by geologists. Mr. Phillips's first teachings were under his father's eye, but he died when John Phillips was but seven years old, and he lost his mother soon after. The subsequent life of the orphan-boy was directed by his uncle, so well known at that time as "Strata Smith." How directed may be judged of by the result, and by the fondness with which Prof. Phillips dwells on his memory. In his "Memoirs of William Smith," he says, "No one interested in the annals of science would desire that such records of one of its eminent cultivators should be lost; but the writer, an orphan who benefited by his goodness, a pupil who was trained up under his care, feels it a privilege and a duty to endeavour to save from neglect the memory of such a man."

Before his tenth year John Phillips had passed through four schools, after which he entered the long forgotten, but much-to-be-commended old school at Holt Spa, in Wiltshire. Although an ardent lover of athletic sports at school, he was nevertheless an incessant worker, taking the greatest delight in Latin, French, and mathematics. The boys were required to write a good deal of Latin, especially one Sunday theme, and much exercised in recitation. John Phillips worked through Mole's Algebra, Simpson's Euclid, the two first books completely, and selections from the others. Of Greek he learned merely the rudiments, to be expanded in after life.

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[1] See notice of William Smith, "The father of English Geology," in the Geological Magazine, 1869, Vol. VI., p. 356.

In the year 1800, the year in which his nephew was born, William Smith had constructed and coloured a map which connected the rock-structure of the north of England with that of the south-western districts, and delineated the Oolitic series through England with considerable accuracy. When it is remembered that nothing of this kind had ever before been attempted, and that this was done by one who had educated himself for and was practising as a civil engineer and land-surveyor, the force of character existing in its author will be evident, and its influences are apparent in the progress of the nephew.

After leaving school, John Phillips resided for twelve months with the Rev. Benjamin Richardson, of Farley Castle, near Bath, one of the best naturalists in the West of England, and a man of excellent acquirements. To his daily and hourly intercourse with this gentleman, to his talk on plants, and his curiously rich old library, and his sympathy with all good knowledge, Mr. Phillips attributes much of his success in those pursuits in which he has so greatly distinguished himself.

From the rectory of Farley, John Phillips was transferred to his uncle Smith's house, which looked out on the Thames from the eastern end of Buckingham Street. There a new kind of life awaited him. Mr. William Smith was a man in the exercise of a lucrative and honourable profession, who had for many years given every spare moment and every spare shilling to the execution of his vast work,—the map of the strata of England and Wales. His house was full of maps, sections, models, and collections of fossils. His hourly talk was of the laws of stratification, the succession of organic life, the practical value of geology,—its importance in agriculture, engineering, and commerce,—its connection with physical geography,—its influence on the occupation of different people, and the distribution of different races.

In 1815 Mr. William Smith published his large map, on a scale of five miles to one inch. This remarkable work brought him into notice, and he was, in consequence, largely employed in constructing geological maps of counties and estates. In this work he was now assisted by his nephew, who accompanied him on his tours and whom he employed in sketching. In 1819 Mr. Smith undertook to walk through Lincolnshire into Oxfordshire. "On this, as on almost every journey for the last three years, Mr. Phillips was his glad companion, *haud passibus æquis*; and, according to an established custom on all such tours, he was employed in sketching parts of the road and noticing on maps the geological features of the country."

In 1821 "he walked through the eastern parts of Yorkshire, and rejoined Mr. Smith at Doncaster, and from this point accompanied him in a walking excursion through the coal district of the West Riding." In a similar way, with his uncle for his guide and instructor, Mr. Phillips very carefully surveyed other districts, especially Yorkshire, Derbyshire, Lancashire, and the Lake district. In the "Memoirs of William Smith" (from which we quote) we find many indications of the way in which Mr. Phillips acquired, under his able teacher, his knowledge of geology and mineralogy; a few brief quotations will show this. "Innumerable rambles led us up every glen and across every hill, now sketching waterfalls, anon tracing the boundaries of rocks, or marking the direction of 'diluvial' detritus. . . . For two or three months we were incessantly occupied by investigations of the lead and copper mines actually working, or of which ancient traces remained, in High Pike, Carrock, and the Caldbeck Fells. . . . In the examination which Mr. Smith made of this interesting district, the writer was closely associated, and was stimulated by the extraordinary variety of the minerals in the veins, and in the syenitic and porphyritic rocks, to investigate their crystalline structures and chemical composition, theoretically and experimentally."

In this happy dream of the future expansion of geology, the actual professional work was too often forgotten by William Smith, and at length he found himself compelled to give up his London residence, and wander at "his own sweet will" among those rocks which had been so fatal to his prosperity, though so favourable to his renown.

In the spring of 1824 Mr. Smith accepted the invitation of the Yorkshire Philosophical Society, then lately established, and went to York to deliver a course of lectures on geology. John Phillips was his companion. This was the crisis of his fate. Mr. Phillips was entrusted with the task of arranging the fossils of the Society's Museum, and in the following year he was appointed its keeper. In 1826 Mr. Phillips read a paper before this Society "On the Direction of the Diluvial Currents of Yorkshire," printed, in 1827, in the "Philosophical Magazine;" this was his first contribution to geological literature. In 1829 the collections of the York Museum were removed to a new building erected in the grounds of St. Mary's Abbey. The gate-house of the monastery was rebuilt and fitted up by the Keeper, and here John Phillips felt himself in thoroughly congenial quarters, which he occupied until 1853. Yorkshire became the field of his labours, and with great industry he thoroughly explored that beautiful county. There was scarcely a hill which he did not climb, or a valley which he did not explore. He made more than a thousand barometric observations to determine the physical character of the county, and gave the world the result, in his "Illustrations of the Geology of Yorkshire," and subsequently in his "Rivers, Mountains, and Sea-coasts of Yorkshire," in which he tells us his aim was "to win from the hasty traveller an hour's delay at a railway-station, a day's wanderings by the waterfalls, a week's rambling over rocky hills, and to plead with the residents of Yorkshire for a better knowledge of its natural beauties and the memorials of its old inhabitants."

In addition to his office of Keeper of the Museum at York, Mr. Phillips was appointed one of the Secretaries of the Yorkshire Philosophical Society, and in that capacity he delivered many lectures to its members. About 1830 the late Sir David Brewster (then Dr. Brewster) addressed to Mr. Phillips, as Secretary of the Yorkshire Philosophical Society, a letter urging the advantages which would arise from an annual meeting of all the lovers and the cultivators of science. This suggestion was much approved by the Society, especially by Mr. W. V. Harcourt, its first President, and immediately there was issued a circular letter to members of scientific societies and the active cultivators and promoters of science, inviting their attendance at York to consider the propriety of founding an Association for the Advancement of Science. The result was that on the 27th September, 1831, the theatre of the York Museum was filled with eminent men and cultivators of science from all parts of the country. Viscount Milton was the chairman on the occasion. Mr. Harcourt suggested a code of laws, and Mr. Phillips commenced his labours as secretary. Then and there was established the "British Association for the Advancement of Science,"—"to give a stronger impulse and a more systematic direction to scientific inquiry; to promote the intercourse of those who cultivate science in different parts of the British empire with one another, and with foreign philosophers; to obtain a more general attention to the objects of science, and a removal of any disadvantages of a public kind which impede its progress." The second meeting was held at Oxford, when Mr. Phillips was chosen Assistant General Secretary, which office he held with untiring zeal, and to the general satisfaction of all members, until 1863. The position achieved by the British Association is almost entirely due to the unwearying energy, the constant industry, and the uniform courtesy displayed by Mr. Phillips. In 1834 Mr. Phillips was elected a Fellow of the Royal Society, and in the same year the Chair of Geology in King's College, London, was offered to and accepted by him. He held this appointment for six years, giving annually one course of lectures, and then returning to resume with undiminished energies his favourite duties at York.

The Geological Survey of the United Kingdom, which is now extended, under the direction of Sir Roderick Murchison, Bart., over the length and breadth of these islands, was originated and commenced by Sir Henry De La Beche in 1835. His first "Report on the Geology of Cornwall, Devon, and West Somerset" was published in 1839. Upon the recommendation of De La Beche, the Lords Commissioners of Her Majesty's Treasury appointed Mr. John Phillips "to examine and describe, for the purpose of publication, the organic remains of the older strata" of western England. Mr. Phillips entered with zeal upon this work, and in 1841 was published "Figures and Description of Palæozoic Fossils of Cornwall, Devon, and West Somerset." In this work Mr. Phillips says, "I have given or applied names to 277 animal structures in the palæozoic strata of the district under review, and in illustration of these about 750 figures (including magnified parts) have been found necessary." In 1842 Mr. Phillips had commenced a geological survey of the Malvern Hills, and in 1849 he furnished the Geological Survey, with an extensive and valuable memoir, "The Malvern Hills compared with the Palæozoic Districts of Abberley, Woolhope, May Hill, Tortworth, and Usk," which may justly be regarded as one of his most masterly labours. Previously to this, in 1840, Mr. Phillips resigned the charge of the York Museum, but continued as Honorary Curator until 1844, in which year he was appointed Professor of Geology in the University of Dublin. In 1845 he received from the Geological Society the Wollaston medal.

In 1849 there had been some severe explosions of fire-damp, and the great loss of life consequent on them compelled the Government to institute an especial inquiry into the system of ventilation adopted in our coal-mines. Prof. John Phillips and Mr. J. Kenyon Blackwell were appointed Commissioners to inquire into and report on this. In 1850 these gentlemen made their reports, Prof. Phillips taking the Northumberland, Durham, and Yorkshire Collieries; Mr. J. K. Blackwell dealing with the other parts of the kingdom. They recommended a systematic inspection under Government authority, and this recommendation being adopted, the colliery inspectors, now numbering twelve, were appointed.

In 1853, after the melancholy death of Mr. Strickland, who was killed upon a railway immediately after the meeting of the British Association at Hull, and who had performed the duties of the Chair of Geology in the place of Dr. Buckland, Mr. Phillips accepted the appointment to the vacant post, and, on the death of the Dean of Westminster, he became his successor as Reader in Geology in the University of Oxford. In 1859 Prof. Phillips was chosen President of the Geological Society of London, and in May, 1860, he delivered the Rede Lecture to the University of Cambridge, which was subsequently expanded into his popular work, "Life on the Earth, its Origin and Succession." In this admirable contribution to the literature of science, he vindicates the introduction of the idea of definite government as an indispensable part of the data for argument on the beginning and progress of life. "No one," he says, "who has advanced so far in philosophy as to have thought of one thing in relation to another, will ever be satisfied with laws which had no author, works which had no maker, co-ordinations which had no designer."

The writings of Prof. Phillips are very numerous: his geological communications exceed seventy in number, and there are more than a dozen on other branches of study. Not only has Prof. Phillips been most zealously employed in looking into the arcana of time, but he has, amongst his later intellectual exercises, been searching into the arcana of space. In 1853, at the Hull Meeting of the British Association, Mr. Phillips exhibited some photographs of the moon, and made a communication which was most suggestive, and has no doubt aided in the final production of those magnificent photographs of our satellite which have been produced by Mr. Warren De La Rue. This interesting subject has continued to claim much of the attention of the Oxford Professor of Geology, and several communications have been made by him to the British Association. We find him also communicating to the Royal Society, "Notes on the Drawing of 'Copernicus' presented to the Royal Society by P. A. Secchi" (1856); "Suggestions for the Attainment of a Systematic Representation of the Physical Aspect of the Moon" (1862); "On the Telescopic Appearance of the Planet Mars," and "On the Belt of Jupiter" (1863); "Notice of the Surface of the Sun," and "Notice of a Spot on the Sun observed at intervals during one Rotation" (1865). An interesting article on "The Planet Mars," from the same pen, appears in the "Quarterly Journal of Science," for July, 1865, in which he shows from his own researches, confirmed by the observations of others, that Mars is a planet "whose main characters of surface correspond to those of our earth, which has nearly the same density, nearly the same daily and nightly period, and is enveloped, like our earth, by an atmosphere partially loaded with scattered clouds, etc."

At Bath, in 1864, he was elected President of the British Association for 1865, and delivered the inaugural address before one of the largest assemblages of that body at Birmingham.

Meteorology is one of the subjects which has been carefully studied by Prof. Phillips, and its bearings on geological theory have been much employed in his treatises. Curious methods of measuring winds; registering the direction and inclination of a rain-drop; the variation in quantity of rain as we ascend above the earth's surface; an exact maximum thermometer, and a self-discharging electrophorus; are connected with the pleasant variations of study which have constituted his only valued amusements.

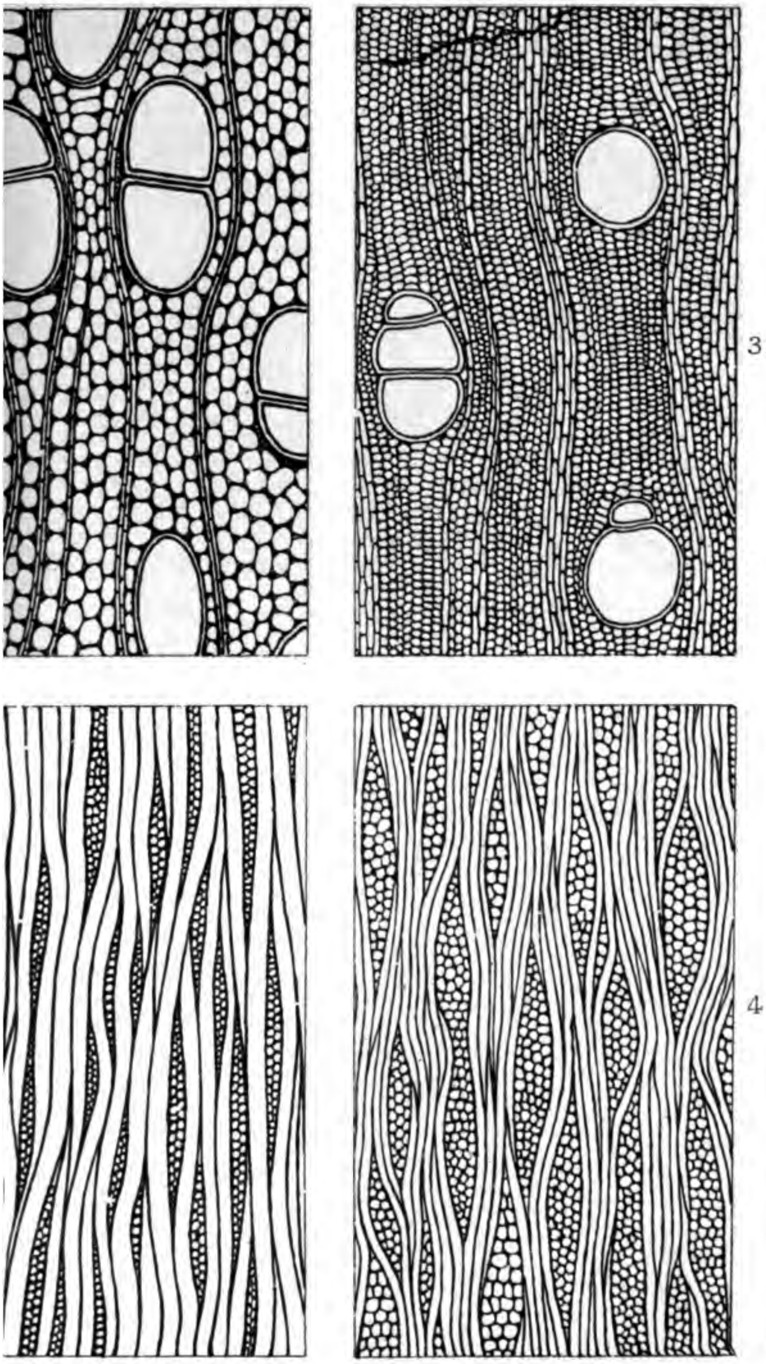
Amongst his more recent labours, we may point to the new Museum at Oxford, which has greatly profited by his experienced hand and well-trained method. By his amiable disposition and the simplicity of his character he has charmed all who have ever been brought within the sphere of his influence. Few men have won more friends. The scientific institutions of all parts of the world have sought to do him honour; and it must be in the highest degree gratifying to Professor Phillips to feel that they have been unsought, and are therefore the genuine recognitions of appreciated industry.

II.—On the Petrified Forest near Cairo.

By W. Carruthers, F.L.S., F.G.S., etc.

(PLATE XIV.)

THE fossil wood which covers the desert to the east of Cairo has long filled the passing traveller on this great Eastern high road with surprise. The immense quantity of what seems to be decaying wood in a region described as a "dreary arid expanse, treeless and almost shrubless, rugged with dark-coloured knolls, and intersected



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Fossil Wood from Egypt
1 & 2. Nicolia Owenii, Carr. 3 & 4. N. Ægyptiaca, Ung.

by a few dry rain-channels," excites, by the remarkable contrast of the present with what is apparently the not far distant past, the wonder of the most careless observer. So vividly has this impressed the imagination of travellers that they have without hesitation correlated the fossil stems with the existing vegetation of Egypt. Burckhardt thought they were petrified date-trees, Mr. Holroyd referred them to the Doom-palm, and, to give an air of scientific accuracy to his determination, he adds the systematic name of the species (*Crucifera Thebaica*). Even the accurate "Murray," in his "Handbook for Travellers in Egypt," (1867) speaks of the specimens as palms, and a learned commentator, "A. C. S.," gets into raptures over the remarkable petrified palms which he found *in situ* (p. 156). I must add, however, that Gardiner Wilkinson, the author of the Handbook, refers to branched and thorn-bearing trees, as well as palms; and besides these, he says there are "some jointed stems resembling bamboos, one of which was about 15 feet long, broken at each of the knots. A small one given by me to the British Museum has rather the character of an *Equisetum*." This specimen is a cylindrical fragment of *Nicolia Ægyptiaca* (Ung.), 18 inches long and 4 inches in diameter. It has several irregular transverse fissures, filled in with quartz, which has more successfully resisted the weathering than the body of the fossil; hence, the fissures stand out as ridges. A small, stout base of a branch projects for 2 inches from the middle of the specimen. So that this equisetacious bamboo as well as the palms are really the same as the branched and thorn-bearing trees of Wilkinson—the *Nicolia Ægyptiaca* of Unger. Newbold (Quart. Journ. Geol. Soc. vol. iv. p. 352) describes the fossils as resembling in external aspect the present palm of Egypt, but internally showing the wood arranged in annular concentric layers, as in exogenous stems. A few, he says, exhibited externally longitudinal fibres intersected at intervals from two to three feet asunder by transverse divisions, giving the trunk the appearance of a gigantic calamite, although the internal structure is that of dicotyledonous wood. He submitted his specimens to Robert Brown, who determined that they were dicotyledonous, but not Coniferous. The late Prof. Unger has published a valuable account of his investigation of the woods which he inspected in their native locality (Sitzungberichte Math.-Naturw. Classe Akad. Vienna, vol. xxxiii. p. 209). He further examined a camel's load of specimens brought home by Kotschy, and determined that they all belonged to one species, to which he had already given the name *Nicolia Ægyptiaca* (Endlicher's Genera Plantarum, Suppl. II. p. 102).

When Prof. Owen visited the "Fossil Forest," in the beginning of 1869, he collected a large series of specimens, which, on his return, he kindly placed in my hands for examination. I had a number of microscopic sections made, and had the satisfaction of determining the existence of a second species.

This extensive collection of silicified stems occurs in the Suez desert, about seven miles east by south from Cairo. Newbold says, "The area they cover is about four miles east and west, and three miles and a half north and south. Many of the trunks lie loosely scattered over the surface amid rolled and angular fragments of dark grit, pebbles of chert, jasper, and quartz." They are of various lengths and size. The largest Unger saw were from 50 to 60 feet long. Similar measurements have been given by Newbold[1] and D'Hericourt.[2] The specimens are frequently deeply fissured transversely, suggesting, as we have seen, the notion of a jointed stem like a bamboo or calamite. The fissures sometimes pass right through, so as to break up a long stem into numerous fragments, a foot or two in length. Neither branches nor roots are found attached to the stems, nor has any trace of bark been detected. Externally they have a striated, fibrous appearance, as if they had been considerably decayed before being silicified. This external appearance, no doubt, suggested the idea of their being fossil *palms*, under which name fragments of them may be met with in almost any provincial museum. The scars of fallen branches are abundant, and always exhibit a considerable hollow at the place, as if the branch had rotted out. The fibrous surface of trunks that have been long exposed has a smooth and polished, almost varnished, appearance, produced by the action of the sand when driven against them by the wind. The wood is generally of a dark reddish-brown colour, and contrasts with the lighter-coloured barren and sandy soil on which it rests or is partially buried. This surface sand rests on a dark-coloured sand and pudding-stone, in which the silicified stems occur, and from which those lying loose on the surface have been washed. This stratum forms the dark-coloured knolls which protrude through the sand, and the stems are seen projecting from the weathered sides of these knolls. They lie horizontally in the sandstone. Newbold says a few have a vertical position, rising from 10 to 20 inches above the surface of the sand. Unger considers this bed to be contemporaneous with the Tertiary nummulitic limestones of Egypt. The forests which supplied the wood flourished, he believes, to the south, and the trunks were brought into the flat deserts by running water, which carried with it, also, the sand and mud in which they are now buried. The different density of the woods sorted them in the flood and influenced their transportation, and accounts for the limited number of species, and the remarkable predominance of one of them.

The wood is converted into chalcedony. The tissues are, on the whole, not well preserved, although occasionally specimens occur in which every cell and vessel is clearly defined. Unger detected in some specimens the branching mycelium of a parasitic fungus, penetrating the cavities of the large ducts, to which he gave the name of *Nyctomyces entoxylinus* (Chloris Protogæa, p. 8. tab. I. fig. 7). In none of the large series of microscopic preparations which I have examined (21 from the specimens collected by Prof. Owen, two from the Bryson Collection, and two from that of Robert Brown) have I been able to detect this fungus. In all of them the ducts are filled with transparent chalcedony, which occasionally shows a dark, amorphous and irregular, sometimes branching core, passing down the centre.

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[1] Quart. Journ. Geol. Soc., vol. iv., p. 349.

[2] Bull. Soc. Geol. France, ser. 2, vol. iii., p. 541.

The chalcedony is more or less filled with minute bodies resembling transverse hexagonal prisms of quartz; but they are thin plates or cavities penetrating the chalcedony in every direction. They have an amorphous centre, and exhibit concentric lines of growth. They do not affect the light differently from the substance in which they are embedded, when examined by the polariscope. Newbold refers to a specimen shown him by M. Linant, at Cairo, which had apparently a somewhat similar structure, but it must have been on a much larger scale, as he does not speak of using any magnifying power in examining it. He says it "had the hollow lined with a white chalcedony-like siliceous substance, full of small cells resembling those of a honey-comb." (loc. cit. p. 353.)

The stems, as determined by Robert Brown, and confirmed by Unger, belong to Angiospermatous dicotyledons, and are made up of the tissues that enter into the composition of such plants. The wood consists of slender prosenchyma, abundantly penetrated by large ducts, which occur singly or arranged, two, three, or even more together. The walls of the ducts are marked with small, regularly arranged oval, or somewhat compressed hexagonal, reticulations. Transverse diaphragms break up the ducts in well preserved specimens into oblong compartments about twice as long as broad. The medullary rays are abundant, and form a considerable proportion of the stem. The concentric layers of wood are not so well defined as one generally finds them in dicotyledonous stems, because of the irregular manner in which the ducts occur throughout the year's growth. In this respect they resemble the walnut rather than the oak.

The histological characters of the stem have been hitherto but little used in systematic botany. A careful examination of numerous specimens, and systematic arrangement of the results, would, no doubt, throw much light on variations in stem-structure, associated with variations in the structures of different plants. But as this has not yet been done, I cannot go beyond R. Brown in saying that, while these stems are dicotyledonous, they are not coniferous.

The genus *Nicolia* was established by Unger in the second supplement to Endlicher's "Genera Plantarum," (p. 102), and was dedicated to William Nicol, who invented the process of slicing and mounting fossil woods for microscopic examination; and who thus supplied the palæontologist with the means of accurate investigation. It may in passing be mentioned in connection with Nicol, that his interesting collection of fossils is now deposited in the British Museum, having formed part of the extensive collection of Alexander Bryson, acquired some two years ago, after the death of that gentleman.

The two species may be thus described.—1. *Nicolia Ægyptiaca* (Ung.), Endl. Gen. Pl. Suppl. ii. p. 102, and Sitzungb. Math. Natur. Cl. Akad. Vien. vol. xxxiii. p. 214, pl. 1, figs. 1 and 2, Plate XIV., Figs. 3 and 4. Wood cells in transverse section small, subquadrangular, about one-tenth of the diameter of the large ducts. Ducts roundish, singly, or two, three, and sometimes four, united in linear series. Medullary rays in transverse section, elliptical, with the ends produced, composed in the centre of the ellipse of four cells in thickness, thinning out until the ends are composed of a single cell.

2. *Nicolia Owenii*, sp. nov., Plate XIV., Figs. 1 and 2. Wood cells in transverse section, large, oval, about one-fifth of the diameter of the large ducts. Ducts oval, singly, or two, or three, united in linear series. Medullary rays in transverse section, linear, doubly acuminate, composed of two cells in thickness at their greatest diameter.

EXPLANATION OF PLATE XIV.

Fig. 1. Transverse section of *Nicolia Owenii*, (Carr.) showing the large oval ducts, the large wood cells and the narrow medullary rays.

Fig. 2. The same in longitudinal tangential section.

Fig. 3. Transverse section of *Nicolia Ægyptiaca*, (Ung.) showing the roundish ducts, small wood cells, and broad medullary rays. The narrow rays are cut through the slender termination of the ellipse.

Fig. 4. The same in longitudinal tangential section.

All the figures are drawn from specimens collected near Cairo by Prof. Owen.

III.—Notes on the Features of Devon, Cornwall, and Galway.

By G. H. Kinahan, M.R.I.A., etc.

DURING a brief visit in Devonshire, the main outlines of the features of the country appeared due to ice sculpture; nevertheless, the vast amount of denudation observable among the hills, evidently the result of meteoric abrasion, caused me to be cautious in coming to a conclusion too quickly, although Mr. G. W. Ormerod, F.G.S. (whose minute knowledge of the district is well known, and with whom I had the pleasure of examining a part of Devon), pointed out that in various places he had found glacier-formed drift. Having subsequently visited both Devon and Cornwall, although time did not permit of a minute search for ice-striæ, yet seemingly the first-formed impressions were correct, and, apparently, ice was the principal agent employed to carve out the main features of this portion of England.

Any observer who is acquainted with the country north of Galway Bay, Ireland, must be struck with the great similarity between the general outlines of that country and Cornwall, more especially the parts of the latter about the Land's End and the other granite tracts; both having long undulating hills, with banks of rocky or moraine drift in the valleys and hummocks of drift on the slopes leading from the gaps. Necessarily, both north of Galway Bay and in Cornwall, although dressed and planed rocks are numerous, yet ice etching is rare, as the nature of the rock favours its obliteration.

It may be asked, if the main features of Cornwall and Devon are due to one and the same agent, why the valleys among the hills formed of the so-called "Devonian rocks" should be so dissimilar to those in the granite and metamorphic rock country? To show that this is not unnatural, and that somewhat parallel conditions occur in the Co. Galway, is the object of these notes.

In Yar-connaught, or that portion of the Co. Galway which lies west of the great lakes (Mask and Corrib), the subjacent rocks are capable of a three-fold division, namely: the granitic, the metamorphic, and the Silurian rocks. The first, comparatively speaking, are of a homogeneous nature; therefore the earlier denudants, the last of which was Ice, formed the country over them into hills and hollows, with long flowing outlines; abrupt valleys or ravines as a rule being uncommon. The metamorphic rocks being very different in their composition, texture, and hardness, have been acted on very differently. Some were chemically hard, others chemically soft; some were very susceptible to mechanical abrasion, while others were the reverse; consequently on some, such as those chemically soft, meteoric denudation would act more than on others, while the same rock might naturally be hard and tenacious, and therefore resist such mechanical denudants as either marine or ice action. On these accounts the outlines of the hills are most irregular, in places having steep, nearly precipitous, sides. Fig. 1. is a sketch of some of these metamorphic rock (quartzite) hills. Among the Silurian rocks, some are hard, others tenacious, but all, except perhaps some of the conglomerates, disintegrate freely; consequently, although the earlier denudants gave the hills general outlines somewhat similar to those formed of the metamorphic rocks, yet subsequently meteoric abrasion has affected them largely; and though most of the hills have long flowing outlines, yet they are intersected by deep tortuous valleys, the sides of the latter being covered by a steep *talus* of meteoric drift.

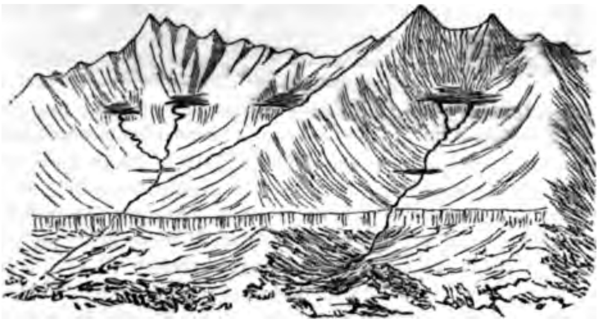

Fig. 1. Derry-clare and Ben Cor, as seen from Lough Inagh, showing terraces on the slopes and flat-bottomed combes or valleys cut into the sides.

In the whole of this part of the Co. Galway (Yar-connaught) it is evident that the features of the country were carved out simultaneously, and the agent or agents that accomplished the work wrought at one and the same time in all parts. In the granite and metamorphic rock countries the traces of marine and ice denudation are seen, though especially in the former, more or less modified by subsequent meteoric denudation. The ice action is apparent by the dressed, planed, polished, and etched rocks, and the marine abrasion by a series of terraces (see Figs. 1 and 3) which occur miles apart on certain horizons, and consequently formed by and due only to a universal agent like marine denudation.[1]

In the Silurian rock country it is hard to estimate what work was done by marine and ice action, for since they ceased, meteoric abrasion has completed so much work that nearly all the conspicuous traces of the other workers are obliterated. Still, however, to an unprejudiced observer it is quite evident that each force performed its allotted part in the great work, for in places on the hill-sides will be found sloping shelves, one of them appearing in the accompanying sketch (Fig. 2), that are apparently the remains of the old sea-terraces modified by meteoric denudation, as they occur at similar heights to the terraces in the adjoining hills. That ice action also played a conspicuous part prior to the present meteoric abrasion is evident, for in some valleys large masses of glacier-formed drift still remain, sometimes even being covered, and therefore preserved, by the meteoric drift. Some writers have stated that the tortuous abrupt deep valleys in Devonshire could not possibly have been formed except by meteoric abrasion. This to me, however, seems an unwarranted assertion; moreover, it appears contrary to facts. In very similar valleys in Yar-connaught, as just stated, moraine drift occurs; and if an observer examines the valleys of West Cork, Ireland, more especially those in the neighbourhood of Hungry Hill, on the north of Bantry Bay, he will find valleys just as tortuous as any in Devonshire evidently ice formed, as their sides and floors are planed, polished, and etched by ice, while at the entrance of some will be found mounds of rocky drift, evidently the debris of terminal moraines. In this comparison between Yar-connaught and Devon, a reference to West Cork appears most applicable, as the rocks of that country are the so-called "Devonian rocks" but harder, and therefore better calculated to resist meteoric abrasion than the rocks of Devonshire. Moreover, if there were the same facilities in West Cork as there are in Devon for meteoric abrasion to work, all traces of glacial action would have disappeared from the

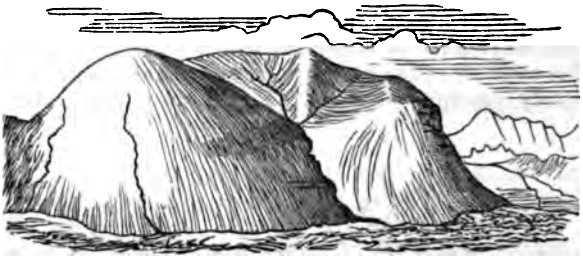

Fig. 2. Hills of Silurian rock (Joyce County Hills), with long meteoric drift slopes. In the distance to the right of the sketch are hills formed of metamorphic rocks.

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[1] Attention was previously directed to these terraces in Clare and Galway. See Geological Magazine, Vol. III., 1866, p. 337, also "Memoirs, Geological Survey, Ireland," Ex. sheets, 105, 115, 116, etc.

valleys among the Cork hills; for at present, as a rule, they are destitute of moraine drift accumulations, it only being found on the flats,[1] at the mouths of the valleys.

It has now been shown it is possible, if not probable, that ice was a more potent agent than meteoric abrasion during the formation of the Devonshire valleys, but it has still to be considered whether the sea could have exerted any influence. My acquaintance with Devonshire is so limited that I may not be justified in offering an opinion; however, as it has been shown there is an analogy between the valleys of that country and those of West Cork and Galway, it may be suggested, that if marine denudation can be proved to have assisted in forming the features of these counties, it probably also helped during the formation of the present surface of Devonshire.

In the west of the Co. Cork, also in Kerry, there are deep semicircular valleys or combes cut into the sides of the hills, remarkable on account of the floors of the different sets being on nearly similar horizons. In these counties the combes are nearly always occupied by lakes in "rock basins," and, as Professor Ramsay suggests, it is highly probable these basins were scooped out by ice; moreover, it is more than probable that subsequently the combes were carved out by marine denudation, not only because their floors are on regular systems of horizons, but also on account of these levels agreeing with those of the combes and terraces of the other hill-groups in Ireland hundreds of miles apart. In West Cork, as just suggested, the features of the combes are supposed to have been modified by ice action, apparently because the rocks were not sufficiently tenacious to be capable of offering much resistance to that denudant. This, however, was not the case among all the hills of Yar-connaught, for although the granite and Silurian ground in places seems to have suffered greatly from ice-action, yet in many places among the hills formed of the metamorphic rocks, the terraces and combes (or *lugs*[2] as they are called in that country) are apparently in nearly a similar state as when the sea retreated from them, having usually a slightly sloping floor, and the lugs rarely, if ever, containing a lake. The accompanying Fig. 3. represents some of these lugs, while others and terraces are seen in Fig. 1. The floors of these lugs, the shelves or terraces cut in the slopes of the hills, and the maums[3] or connecting gaps, here as well as in West Cork, are on different systems of levels, seemingly proving that each system was formed by one and the same denudant, very universal in its operation, and similar to no other force at work during the present age save marine action. That these terraces, combes, lugs, etc., were formed prior to the final disappearance of the ice, is proved by the rocks forming them being dressed, polished, grooved, and etched.[1]

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[1] A letter from Mr. G. W. Ormerod, printed at page 40 of the GEOLOGICAL MAGAZINE for 1869, notices the traces of glacial action in South Devon, and states that probably for the words "*Old Gravels*," used in his paper "On the Geology of the valleys of the upper part of the river Teign and its feeders" (Quart. Journ., vol. xxiii., page 418), the word "*Moraines*" should be substituted.

[2] *Lug*, a valley or gloomy depression among hills.

[3] *Maum* or *Mām*, mountain pass, or connecting gap through a mountain ridge, derived from Mānn (*Mawn*), the inside part or hollow of the hand. (See article on Formation of Ravines, by author, in GEOL. MAG. Vol. VI. 1869, p. 406.)

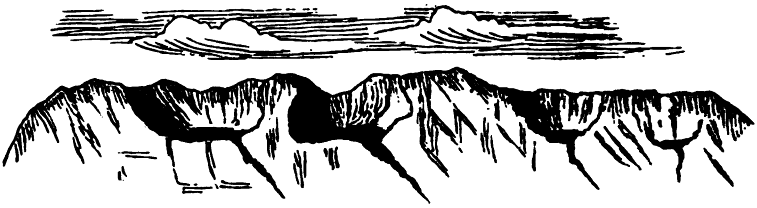

Fig. 3. Flat-bottomed *lugs* cut into the north side of the Muilrea hills.

In the Silurian and granite countries the action of the sea is not so apparent, and a casual observer might not remark any traces of it; however, on the hill-side in many places are sloping terraces, which on comparison are found to be on similar levels to the terraces, etc., just now mentioned, and consequently having a like origin, but now modified or nearly obliterated by the subsequent meteoric abrasion.

It has now been demonstrated that the features of Yar-connaught as they now exist are due to the joint work of the three denudants, namely: *marine action*, *ice*, and *meteoric abrasion*; yet in parts of that country there are now scarcely any traces of marine action, although this force must have acted in those portions prior to the ice and the subsequent meteoric abrasion, as much, if not more, than in the tracts where the traces are still conspicuous. Part of this country in which the traces of marine denudation have been nearly obliterated is formed of Silurian rocks, somewhat similar in character to the grit slabs and slates of Devon (Devonian rocks), and in this part of Yar-connaught the valleys are of the same character, and are very similar to those of Devon. Is it, therefore, unreasonable to suggest that the three forces which jointly formed the present features of Yar-connaught, were also combined in carving out the present surface of Devon, although all conspicuous traces of ice and marine action may have been since obliterated by meteoric abrasion.[2]

IV.—On Volcanos.[3]

By David Forbes, F.R.S., etc.

HAVING listened with much pleasure to several able lectures on Geology and Palæontology which have already been delivered in this Hall, I believe I am correct in affirming, that the general tendency of these discourses has been altogether in one direction;

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[1] In Ireland also there are at least two or three sets of terraces that were formed subsequent to the disappearance of the mass of the ice, but probably prior to the *final* disappearance of the snow on the uplands and the ice-streams in the hill valleys. (See Memoir Geol. Survey, Ireland, ex. sheet, 105.)

[2] There are sloping terraces on some of the hill-sides of Devon and Cornwall, but whether they occur in systems, and consequently are due to marine action, has still to be worked out.

[3] Being the substance of a lecture delivered in St. George's Hall, June 19, 1870.

the object being, to impress forcibly upon your minds the opinion that the various changes which have taken place in the earth's history, inhabitants, and surface configuration, have been mainly effected by what may be termed external agencies, *i.e.*, by forces acting from without, slow but sure in their operations, yet but comparatively so feeble in their energy as to demand a practically unlimited amount of time being placed at their disposal to enable them to accomplish those great revolutions which we see and know to have taken place in the geological history of our globe.

The object of the present discourse, however, is precisely the reverse; for at the same time that I wish you, as I do myself, to realise in your minds and fully appreciate the immense importance of the study of these slow, or as they have been called "uniformitarian," agencies, I would request your attention in quite an opposite direction, in order to point out to you, that if we wish to arrive at sound conclusions on these subjects, we must constantly bear in mind the fact that, from the very oldest periods in the earth's history down to the present day, we have the most clear and incontrovertible evidence to prove the existence of internal agencies also, that is, of forces acting from within the earth itself, which, from their often being at the same time both intensely energetic and instantaneous in their operations, have been termed cataclysmic, in contradistinction to the so-called uniformitarian, or external agencies, before referred to.

Volcanos, which we are about to consider, are but so many existing proofs of the activity of such internal forces at the present moment, and as a geologist I may be almost pardoned if I regret, that we do not in our happy isles possess even a single example of an active volcano. Had we one, it would have immensely aided my efforts to-day; for as the old saying has it, "out of sight, out of mind," I feel that the previous lecturers have in this respect had a great advantage over me, since a mere appeal to your experience and observation at home could not but greatly assist them when explaining to you the effects of rain and rivers, or of ice, or the sea, upon the surface of the ground. I, on the contrary, cannot point out to you even the smoke of one of those subterranean furnaces which form the subject of my discourse.

Although I imagine that but very few of those now present have ever witnessed a volcano in eruption, I feel quite sure that all must have read accounts of such phenomena. During the last few years, indeed I may say months, these have been of more than usually frequent occurrence, and the newspapers have from time to time brought us particulars of considerable volcanic outbreaks, both submarine as well as terrestrial, in various parts of the world, very distinct from one another.

As regards the geographical distribution of recent volcanos, a glance at the geological map of the world will suffice to show that they are in reality scattered all over its surface; yet it may be added, more rarely occurring at any great distance from the sea, although exceptional instances are met with far inland in all the four quarters of the globe. In the north we find the volcanos of Iceland, Jan Mayen, Kamschatka, Alaska, and others; whilst the Antarctic voyages of Ross prove that the mountains of the nearest accessible land to the South Pole are also active volcanos.

At the Equator, all but innumerable volcanos are seen in the islands of the Indian and Polynesian Archipelagos, as well as in the Pacific and Atlantic Oceans, and on the mainland of South America. Midway between the Equator and the Poles are situate the volcanos of New Zealand, the Canaries, Cape Verde, Azores, and Sandwich Islands, as also those of Arabia, Eastern Africa, Mexico, Central America, and the volcanos of the whole range of the Andes down to Tierra del Fuego.

Nearer home, Vesuvius, Etna, Stromboli, Santorin, and numerous others in the Mediterranean, if not so grand in their dimensions as some of those previously referred to, still present on the large scale all the various aspects of volcanic phenomena, both submarine as well as terrestrial.

If now, however, we take a broader view of volcanic phenomena, —and in addition to the before-mentioned still existing proofs of the general distribution of volcanic centres, as they have been termed, we also take into consideration the occurrence of eruptive rocks of similar origin, which are everywhere found disturbing and breaking through the strata of even the oldest rock formations,—it will be seen, at least as far as the geology of the earth's surface is at present known to us, that there is scarcely a single area of any magnitude—of either the land or sea—which at some period or other has not been broken through or disturbed by what may be termed volcanic forces, acting from within the mass of the earth itself; and it is impossible to come to other than the conclusion that these agencies must have played a most important part in determining the main features of the earth's external configuration as well in our times as throughout all periods of its history.

Should the question be asked, What is a volcano?—the simplest reply would be, "A hole in the ground deep enough to reach such portions of the interior of the earth as are in a molten condition."

In ordinary language, however, the appellation of "volcano" is usually restricted to those cone-shaped mountains, from the hollow summits of which flames, smoke, and vapours are at times seen to ascend, and which occasionally break out into more imposing activity by vomiting forth showers of ashes and fragments of incandescent rock, or by pouring out torrents of molten stone, to deluge and devastate the unfortunate country in the vicinity.

The numerous interesting descriptions and figures of volcanic mountains, like Vesuvius and others, which have appeared in popular as well as scientific publications, have no doubt made you all quite familiar with the external features of a volcano, both when at rest and in action, so that a description from me would be superfluous; the internal structure and mode of formation of each mountain requires, however, some consideration, more especially as these points were for a long time a subject of discussion among geologists.

It having always been admitted that volcanos owed their origin to forces operating from below, it was suggested by Von Buch, and supported by Humboldt and others, that volcanic cones must be formed by some portion of the surface of the earth weaker than the rest being forced out, or as it were blown up like a soap-bubble, by the pressure of the vapour and gases confined below, the strata being thereby elevated, fractured, and tilted up on all sides, so as to produce a conical elevation, the central fissure in which became a crater or vent for the escape and passage of the gaseous and liquid emanations from below.

This hypothesis, which accounted for the formation of volcanic cones and craters by a process of upheaval, or as it was termed the "Crater of Elevation," is here alluded to, only because it for a long time was accepted by many eminent men of science, until the subsequent researches, especially of Mr. Scrope and Sir Charles Lyell, demonstrated conclusively that it is not confirmed when their actual structure is studied in the field, and explained their true formation by what is now termed the "Crater of Eruption" theory.

If we imagine a volcanic cone cut through its centre, so as to present us with a section of its entire mass, it will be seen that the mineral matter of which it is composed possesses in itself a sort of arrangement in layers, which at first sight somewhat resembles beds of ordinary sedimentary origin broken through and tilted up towards the centre; a closer examination, however, shows that these layers were never at any time horizontal, but that, on the contrary, they had, from the very first, been deposited in the same inclined position in which they are now seen, and that they must have been formed subsequently, not previous to the opening of the crater itself, since they are entirely composed of matter thrown up from its orifice. Every step in the formation of such volcanic cones has now been carefully studied and described; and as I have myself had good opportunities for watching their construction during most of the stages, I shall attempt a short description of the general features of a volcanic eruption.

The commencement of an eruption is known in most cases by certain preliminary symptoms indicative of great internal disturbance, such as rumbling noises and sounds, as if of explosions below, which have been likened to subterranean thunder; the surface waters, springs and wells in the vicinity, generally acquire an unusually high temperature, diminish in volume or disappear altogether, and repeated earthquake shocks more or less severe are felt, which eventually culminate in a grand convulsion, by which the surface is rent asunder with fearful violence, allowing immense volumes of previously pent-up vapour and gases to rush forth from the fissure, with such impetuosity as to hurl high into the air huge fragments of the shattered rocks, along with large quantities of molten lava, in so liquid a condition, that during its ascent it is seen to be splashed about in the air like water, and to become separated into particles of all sizes. Vast quantities of these particles, to which the name of volcanic ash or dust has been applied, are instantaneously reduced to so fine a state of division, literally "blown to atoms," as to become converted into an almost impalpable powder, capable of being carried away by the winds prevailing during an eruption to distances of even hundreds of miles from the orifice from which they had been ejected, and ultimately settle down on the land or in the sea to form deposits, whose nature would often be a puzzle to geologists, did not the microscope at once reveal their true mineral character and volcanic origin.

Other particles, less finely divided, become granulated and fall down from the air in the shape of small black grains known as volcanic sand; whilst still larger portions, owing to the bubbles of vapour or gas entangled in their substance, descend as black porous or spongy stones, from the size of a pea to that of one's head or larger, and have received the names of lapilli, scoriæ, or volcanic cinders, from their presenting much the appearance of an ordinary cinder from a coal fire. Although the scoriæ thrown up by volcanos are in major part of a dark colour, there are also others (called trachytic) much lighter both in colour and weight, which are usually more common at the commencement of an eruption; and the ordinary pumice stone, which is imported in large quantities from the volcanos in the Lipari Islands, for the use of painters, etc., is an example of this variety familiar to you all.

A peculiar form of lava is produced by the currents of wind blowing over the surface of the molten matter in the crater catching up portions of it and drawing them out into long, slender filaments, like hair or spun glass, of all shades of black, brown, or yellow. In the Sandwich Islands, where this variety is very abundant, it is called Pele's hair, from the name of one of their ancient goddesses.

In the intervals of an eruption, or after the greatest force of the rush has spent itself, the vapours often rise through the molten lava in the crater in smart puffs, which carry up with them portions of the fluid lava high into the air, whence they descend consolidated as spheres or somewhat elongated bodies, consisting of an external shell of solid lava, hollow, or only filled with vapour or gas in the centre. From their resemblance to military projectiles, these bodies, which vary from the size of an orange to that of a pumpkin, have received the name of volcanic bombs.

The mineral matter thrown up into the air from a volcanic vent necessarily descends again by virtue of its own weight; a portion drops back into the crater, but the major part falling beyond it accumulates around its brink to form a mound, which, since the larger and heavier pieces are not projected to so great a distance as the others, keeps, as it increases in size, raising itself more rapidly in height nearest around the vent, than further off, and thus builds up a hollow cone, the throat or chimney of which is kept open, at least during the continuance of an eruption, by the upward rush of the gases and vapour forced through by the pressure below.

The action of the heat, being, of course, much more intense in the chimney or throat of the crater, now causes the at first comparatively loose materials which formed its walls to soften and cement themselves together on the inside into a sort of compact stony tube of communication with the lower regions, much more solid and resistant than the rest of the mass, of which, as before described, the entire cone had been built up. Once this is the case, the molten lava, forced up by the gaseous pressure below, frequently ascends into the crater itself, and overflowing its brim pours down the outside of the cone, just like water when placed over too rapid a fire is seen to boil over the edge of the pot in which it is heated.

These occasional overflows of lava explain how in the section of a volcanic cone layers of more compact lava are so frequently seen alternating with those of the porous scoriæ and volcanic sand before described.

In more rare instances, as for example in the eruption of Mauna Loa, in the Sandwich Islands, in February, 1859, the lava is ejected in so wonderfully liquid a condition, and in such enormous volumes, as to present the appearance of a red-hot fountain; the jet of molten lava thrown up from the crater on that occasion is described as about 250 feet in diameter, and as rising some 500 feet above the level of the brim of the crater itself.

Occasionally, during an eruption, the rim of the crater, unable to support the weight of the molten lava which fills it, gives way at its weakest point, the lava bursting out and carrying away one side of the cone itself; at other times the lava, after having risen some height up the crater, finds out a point of weakness and breaks through, discharging itself by a fissure some way up the side of the cone, as was the case with the volcano of Sajama, in Bolivia, in 1859, and with Etna in 1865.

In many eruptions the lava does not ascend at all into the crater, but breaks out at the very base of the cone, or even at some considerable distance from it through some subterranean passage; this took place in the eruption of Kilauea, in the Sandwich Islands, in June, 1840, when the lava first showed itself at the surface at Arare, some six miles eastwards of the crater which supplied it.

In fact, most volcanos will, upon examination, be found, at one or other period of their history, to have presented examples of more than one, if not of all these different modes of discharging their molten products.

The eruption of Etna, in 1865, which I witnessed, did not proceed from the summit or main crater, but broke out on the side of the mountain, about 5,000 feet above the level of the sea. Along the fissure or rent formed by the convulsion, no less than seven distinct cones rose up at intervals, building themselves up very rapidly from the enormous quantities of scoriæ which were thrown up from their vents; as they became larger, the bases of several of these cones extended until they united, and so formed a range of hills, the summits of which, in but a few weeks, reached the height of several hundred feet, and totally changed the character of scenery of this part of the island. The four lowest cones were the most active, but from none of their craters was there any overflow of lava, which, however, poured out from the very base of the cones, forming a fiery river apparently about three miles across, which destroyed all before it, cutting through a large pine forest, and at one place leaping like a cascade of liquid fire over a precipice some 150 feet in height.

The formation of a new, or re-opening of an old volcanic vent, is usually accompanied by a terrific explosion, often to be heard at immense distances; thus in 1812, the outburst of the volcano of San Vincent was heard in the north of South America, some 700 miles distant. The enormous force developed by the rush of gases and vapours from the fissure may be imagined, when it is known that in the eruption of Mount Ararat, in 1840, huge masses of rocks, weighing as much as 25 tons, were thrown out of the crater. Cotopaxi is said to have even hurled a 200-ton rock to a distance of nine miles, while the volcano of Antuco, in Chili, in 1828, sent stones flying to a distance of 36 miles from its orifice.

The issue of gaseous matter from the crater of a volcano is often described as a column of flame—this is incorrect; for although possibly a little burning hydrogen, or sulphuretted hydrogen might be present, especially on the outer edge of the column, the appearance of the column or fountain of flame is in reality due to the gaseous matter of which it consists being illuminated by the fragments of red-hot rock and molten lava thrown up along with it (like sparks in fireworks), assisted by the reflection from the red-hot sides of the crater itself, and from the surface of the molten lava below.

The chemical composition of the gasiform emanations from volcanos proves that they are in greater part incombustible, and therefore does not support the idea that the body of such a column of vapour and gases could be in flames, *i.e.*, actually burning. On the outside of the column, however, innumerable brilliant scintillations of a bluish colour are frequently seen, due to particles of sulphur taking fire as they come in contact with the outer air, and patches of melted sulphur are splashed about, burning brightly as they fall through the air on to the slopes of the cone. The emission, or belching forth, as it has been called, of the gaseous matter, with its accompanying red-hot ashes and scoriæ, is more an intermittent than a continuous operation. When an eruption is at its height, the spasmodic puffs or blasts are jerked out at intervals of but a few seconds, attended by a terrific roaring or bellowing noise difficult to describe in words.

The buried cities of Stabiæ, Herculaneum, and Pompeii, covered up in parts to the depth of 100 feet with the ashes of Vesuvius, are ocular proofs of the vast quantity which can be sent out of a volcanic vent during an eruption. The volcano of Sangay in Ecuador, in constant activity since 1728, has buried the country around it to a depth of 4000 feet under its ashes, and a French geologist has estimated that in the course of only two days the volcano of Bourbon has thrown out no less than 300,000 tons of volcanic ashes. The immense distances to which these ashes may be transported by the winds is no less surprising; the ashes of Vesuvius in the eruption which buried Pompeii darkened the sun at Rome, and were carried as far as Syria and Egypt. Those from San Vincent in 1812 are reported to have made the sky as dark as night in the Barbadoes; and in Iceland in 1766 the air became so charged with ashes for a distance of 150 miles around Hecla, that even the brightest light could not be distinguished at a few yards.

Amongst the still active volcanos, we meet with some whose craters are several miles in diameter, encircled by precipitous sides, rising to even a thousand feet above the bottom of the crater when at rest, which, as in the Sandwich Islands, may contain reservoirs or rather lakes of liquid lava, two to four miles across, and at times send forth rivers of molten stone several miles in breadth, extending their fiery inundation to a distance of even 40 miles from the crater whence they issued. In the eruption of Hualalia in 1801, a lava current, after reaching the coast, poured out such volumes of lava as to fill up a bay some twenty miles deep, and in its place extend a headland some three or four miles further into the sea.

The rate at which these rivers of molten stone flow is a very varying one; in 1805 the lava current from Vesuvius is said to have run down the first three miles in four minutes, yet only completed its total distance of six miles in three hours; and in 1840 that from Mauna Loa advanced no less than 18 miles in two hours; whilst, on the other hand, it is recorded that during the eruption of Etna which commenced in 1614 and continued many years, the lava stream only completed a distance of six miles in 10 years, notwithstanding that all this time it was seen to be in slow but almost imperceptible motion. During the eruption of this volcano in 1865, I found, however, that at the edge of the current the rate of motion varied from 15 to 120 feet per hour, according to local circumstances, whilst in the centre of the stream the lava was evidently still more rapid in its movements. The entire mass of a lava stream often advances even when to the eye it would appear to have become quite solid. Upon my throwing a heavy stone on to the top of a lava current so far consolidated that the stone merely fixed itself into the surface without sinking deeper, it was seen that the stone moved along with the lava, which otherwise looked as if stationary.

The surface of this lava consolidated and cooled with almost incredible rapidity. Notwithstanding the protestation of my guides, I walked over lava currents when, at the same time, the fiery stream, still flowing below, could be distinctly seen through the cracks in the crust over which I passed.

On this occasion, also, the stems of the pine-trees in the forest which was destroyed by this eruption were converted into charcoal as high as the lava reached, but the upper portions of the trees then toppled over, and remained in an almost unaltered and uncharred condition on the top of the lava current, which had so quickly cooled. The crust which forms on the top of the lava when cooling, being an excellent non-conductor, acts so efficiently in preventing further escape of heat, that we find streams of lava requiring many years and even ages to become quite cold. Dolomieu relates that the lower part of the Ischia lava of 1301 was still hot in the year 1785.

When, owing to the disruptions of the ground around volcanos, the water from springs, rivers, lakes, or the sea itself, is brought into contact with the heated mineral matter below, we have the production of the so-called mud volcanos, or of fissures sending forth torrents of heated mud and water, and often throwing out numbers of fishes which had lived previously in these sources. The Geysers of Iceland present somewhat similar phenomena, but on this occasion, time will not permit these subjects being treated in detail.

Whilst some volcanos, like Stromboli (the lighthouse of the Mediterranean, as it was called by the ancients), have continued in incessant activity from the oldest historical periods down to the present day, the eruptions of others are only known to have taken place at long intervals. Vesuvius, although imagined by Strabo to have had a volcanic origin, was not known even by tradition to have ever been in eruption until the year 79, when Pompeii was overwhelmed by it. Since that time, however, up to the present date, it has given ample proofs of its volcanic activity; yet its history shows several intervals of a century, and one of more than two centuries, in which no eruption took place. No outbreak of the volcano Sangay, in Ecuador, is recorded before 1728, since which year it has been in continued activity; and Krabla, in Iceland, also remained at rest for several hundred years before 1724. In fact, it may be safely affirmed that it is quite impossible for us to know whether any volcano at all is entitled to be regarded as really extinct.

Even for ages after the last outburst of lava it is found that smoke and acid vapours continue to be given off from most volcanic vents, and the extraction of the sulphur found in the craters, and sublimed into the fissures around dormant volcanos, forms in many countries an important branch of industry.

Although as yet I have confined my remarks altogether to terrestrial volcanos, it must not be supposed that the depths of the sea are exempt from such visitations, and in the last few years we have had several prominent examples to the contrary in different parts of the world. Submarine volcanos were well known to the ancients. Pliny and older writers refer to those in the Mediterranean which threw up the islands of Delos, Rhodes, Anappe, Nea, etc. In the Cyclades, very curious examples have occurred, both in very ancient and in the most recent times. Of these islands, Therasia is recorded to have been formed in the third century B.C.; as also, somewhat later in the same century, the island of Thera, now called Santorin; subsequently Hiera, 91 B.C., and then Thea, A.D. 19, appeared, which last two were in 726 united by an eruption, and together form the present island of Kaimeni. In 1575, a smaller island, called Little Kaimeni, showed itself, around which in 1650 numerous other islets were thrown up, which were united to Little Kaimeni during the eruptions which continued from 1707 to 1812, when the island, thus increased in size, became known as New Kaimeni. Finally, the last eruption (still going on) which commenced 28th January, 1866, presented us on the 2nd February with a new island, now called King George's Island, from the present King of Greece, which, according to the latest accounts, still continues to increase in size. Numerous other examples might be cited, but I shall only mention the island of Johanna Bogoslawa, in Alaska, which, although it only first showed itself above the water in May, 1796, had in 1806 increased so as to be an immense volcanic island, the summit of which was then elevated to no less than 3,000 feet above the level of the sea.

The volcanic products thus forced out under the sea present, as might be expected, a very different aspect from that of the ashes, scoriæ, and lava from terrestrial volcanos; the molten lava, coming in contact with the water, is at once broken up into fragments, coarser or finer in proportion to the greater or less cooling power of the water in immediate contact with them, and often in great part instantly converted into fine mud, of a greyish colour when formed from trachytic lava, but more commonly of a chocolate or other dark tint, and much denser when produced from the more prevalent pyroxenic lava. Beds of this character, spread out by the action of the sea, often inclosing shells, fish, and other organic remains, become in time consolidated and upheaved, and as they often present an appearance much resembling ordinary volcanic rocks, they have frequently puzzled geologists, who at first found a difficulty in explaining the presence of such fossils in rocks apparently of igneous origin.

As the limits of this discourse will not permit of my going further into the consideration of these phenomena, or of even more than touching upon the chemistry or mineralogy of volcanos, as I should have wished to do, I must now confine myself to some few remarks upon the origin of volcanos, premising, however, since this subject is still involved in great obscurity, that what I have to say on this head must be received more as an expression of my own opinions than as any yet received theory of volcanic action.

Many writers on this subject hold to the belief that volcanos are mere local phenomena, each one springing from its own comparatively small reservoir of molten matter, supposed to have originated from the softening or fusion of rocks pre-existing on the spot at some depth below the surface.

To me, however, this hypothesis appears altogether untenable, when it is remembered, amongst other objections, which I have elsewhere considered, that volcanic rocks are encountered in all parts of our globe, often continuous or nearly so, over immense areas; and also that all these rocks, without reference to the part of the world in which they occur, are invariably alike in character to one another.

Volcanic rocks may be classified under two heads, viz., the dark coloured, more dense; and the less heavy, light-coloured lavas—termed respectively the basic or pyroxenic, and the acid or trachytic lavas. Both these varieties may proceed from the same volcanic vent in succession; for instance, in Vesuvius, where the mineral matter which buried Pompeii is trachytic, but the later lavas are generally pyroxenic in character; this also was the case in the recent eruption of Santorin, as reported upon by the Austrian Scientific Commission.

The examination of volcanic products, no matter how distant the volcanos may be from one another whence they are taken, proves them to be altogether identical in general mineral and chemical constitution.

Mallet, as the result of experimental researches, supposes that Vesuvius in the later eruptions drew its supply of molten matter from a depth of somewhat more than eight miles below the surface; and geologists have variously estimated the thickness of the total sedimentary rocks which are known to them at the surface of the earth at from seven to seventeen miles: we also know from observations in deep mines and artesian wells, that the temperature of the earth's crust increases as we descend, about two degrees for every hundred feet in depth; so that at this rate a temperature sufficiently high to keep lava in fusion would be met with at less than twenty miles below our feet. Taking all these and other data into due consideration, I cannot arrive at any other conclusion than that all volcanos are connected with one another in depth, and have one common source, not necessarily situated at any enormous depth below the surface, but in which the molten matter, whilst always retaining certain general characters, has undergone considerable changes in composition, mineralogical and chemical, from time to time in the world's history; for under the term "volcanic rocks," I would here include all eruptive rocks without exception, whether called granites, syenites, porphyrites, basalts, or lavas; all of which I regard as but so many members of one chronological series, or simply as the products of the volcanic action of different geological epochs.

So much for the molten products of volcanos. Now a few words on their gasiform emanations, which consist in greater part of the vapour of water, *i.e.*, steam along with volatile chlorides, hydrochloric and sulphuric acids, nitrogen and sulphuretted hydrogen gases. The sulphur seen to be sublimed in so large quantities is probably derived from the mutual reaction of the sulphurous acid and sulphuretted hydrogen gases as they come into contact with one another.

Now, if it be true that we have a vast accumulation of molten matter at a certain distance below the surface, which observation further informs us must in major part consist of the silicates and sulphides of the metallic elements, then, in my opinion at least, it only requires the assumption that water from the sea should, by some means or other, find its way down into such a reservoir, to account for all the phenomena of volcanos, both mechanical as well as chemical. The greater part of the water so introduced would be at once converted into steam, which in its turn would become still further expanded by a heat so great as that of molten lava, and would develope an enormous power. Calculations have been made which show that water even when heated to a much less temperature would exert an "ejection force," as it has been termed, even exceeding that developed in eruptions of the highest volcanos known. Another portion of the water, with the air carried down along with it, acting upon the highly-heated sulphides, would become decomposed, and furnish the sulphuretted hydrogen, sulphurous acid, and nitrogen gases, given off; whilst the common salt in the sea-water, by its action on the hot silicates in presence of steam, would eliminate hydrochloric acid, and account for the appearance of it, as well as of the volatile chlorides found in volcanic fumes. If we accept this explanation, the chemical reactions would be but the effects and not the cause of volcanic phenomena.

The destructive effects attendant on volcanic convulsions are of two different characters, viz.: those arising from the earthquakes which accompany, and as a rule precede, volcanic outbreaks, and those caused by the products ejected from the volcano itself. The connection of earthquakes with volcanos has been noted from the oldest times. The earthquakes which commenced A.D. 63 were but the efforts made by Vesuvius to relieve itself, which culminated in the great eruption in 79; the same was the case in Mexico, with Jorullo, in 1759; and with the great earthquake of 1834, in Chili, which ended in the outbreaks of Osorno and three other volcanos in the Andes; and lastly, in 1868, the terrible earthquake which visited the coast of Peru, and totally destroyed the cities of Arica and Ioquique, was followed by the eruption of Isluga, which, according to the latest news, still continues.

There seems little reason to doubt that all earthquakes are of purely volcanic origin, and that volcanos themselves may be regarded as so many safety-valves for blowing off the surplus steam, gases and molten products from our great internal boiler; for as a rule it has been observed that earthquakes either cease altogether or diminish greatly in violence as soon as a neighbouring volcano has cleared its throat.

Although I have resided several years in what are called earthquake countries, and have experienced numerous and severe shocks, amongst others those which resulted in the total destruction of the cities of Copiapo and Mendoza, on which latter occasion some 20,000 inhabitants perished in the ruins, it seems to me quite impossible to convey in words anything like a true picture of such a dreadful catastrophe. The feeble shocks occasionally felt in England cannot give even the remotest idea of what a severe earthquake is in reality; for not only are cities destroyed and whole villages swallowed up in an instant, as in the case of Argure during the eruption of Mount Ararat in 1840, but when situated on the coast, even when they have withstood the shock itself, they may be entirely swept away by the great sea wave which follows close upon it, as happened with the cities of Arica and Icquique, in Peru, little more than a year ago.

Equally terrible is the destruction caused by the showers of ashes and torrents of molten rock, as in the well-known instances of Pompeii, Herculaneum, and others too numerous to mention; but as time presses, I will, in conclusion, only add some remarks upon the influences which such volcanic or cataclysmic forces exert upon the external configuration of our globe and the features of its scenery. In a lecture published some years ago, when referring to the prime causes which determined the external configuration of the land in the earliest ages,—taking for granted the generally received opinion that the earth was originally a sphere of molten matter, the exterior of which cooled and solidified to form a crust over the still liquid matter in its interior,—after stating that the contraction of this crust, when cooling, would cause cracks or fissures in it, through which some of the still molten matter below would be forced up, or, in other words, form the first lava streams or volcanic outbreaks, I remarked: "The sides of these cracks or fissures would also be frequently more or less dislocated, and so form lines of faults, interrupting the previously regular contours of the surface, and forming the first elevations or mountains on the globe, which, by giving direction to the action of the water in the ocean and rivers, would in great measure determine the main features of the physical geography of this epoch,"—adding, that such primeval causes, by regulating the demarcation and deposition of sedimentary matter, must directly or indirectly continue to influence the main features of external surface configuration, even down to the present day.

There are also good proofs that the great lines of disruption or weakness seen in the earth's crust at present, have, at least in many instances, also been lines of weakness in other and probably in even the very oldest geological epochs. No better example of this can be seen than in that greatest of all mountain ranges, the Andes, where, commencing from the oldest period of their elevation, we find a series of eruptive rocks breaking, one after the other, through the sedimentary strata which form their flanks, as follows:—first, the auriferous granites, probably at the end of the Devonian period; second, the characteristic porphyrites of the Oolitic age; third, the auriferous diorites, disturbing the Cretaceous formation; then, fourth, the Miocene basalts; and, fifth or lastly, the lavas from the present volcanic fissures which occur at intervals along the whole range, from Tierra del Fuego in the south, all through the Cordilleras of South and Central America, up to the Rocky Mountains.

If now, when studying the relative energy displayed by volcanic forces in the older geological periods, we bear in mind that we still have volcanos whose craters, several miles in diameter, send forth at times streams of molten stone 40 miles and more in length, or showers of ashes which bury the surface of the ground to a depth of 400 feet below them, and, furthermore, see volcanic mountains and islands literally rising up before our eyes to an elevation of even thousands of feet, in what, geologically speaking, is but a second of time, it does not to me seem at all necessary to assume that such internal or cataclysmic forces were so much more energetic in any other period than at present.

In the infancy of the science, the cradle of geology was in the last century rent asunder, figuratively speaking, by the schools of Neptune and Pluto, insisting each, in its turn, on the all-powerful action of water or fire in the formation and subsequent changes which have taken place in the earth; and it is to be feared that even now much of this old leaven remains, for there seems to be, as it were, an innate tendency in geologists to attach themselves to some one or other favourite doctrine, uniformitarian or cataclysmic, whichever may for the moment be most in vogue.

British geologists of late years, all but ignoring the action of internal forces, have striven to account for everything in the shape of external configuration or scenery by the action of water in its different forms of rain, rivers, the sea, or ice; and, instead of taking a broader view of the geological features of the land as a whole, may be reasonably accused of allowing themselves to be far too much influenced in their deductions by purely local circumstances at home.

The most prominent features in the scenery of a country must be its mountains, and it is well known, not only that many even of the most lofty mountains in the world are actually volcanos, but also that the greater number of the others, even in the British Isles, are in major part built up of or founded on eruptive rocks, the product of the volcanic and cataclysmic activity of former periods; whilst the countless faults and dislocations of the strata, and the upheaval of vast tracts of country everywhere seen, testify to the magnitude of the results effected by those forces which operate from within the earth itself.

In answering the question, therefore, as to which of these forces has played the most prominent part in determining the external configuration of the earth, the unbiassed geologist must necessarily grant the first rank to the internal volcanic or catalysmic agencies, since had it not been for their operations, our globe would still have remained a comparatively smooth sphere, surrounded by its external envelope of water, with no visible land for the rivers to traverse or the rain and ice to disintegrate and wear away; in fact, it was only after the internal agencies had produced their effects that the external forces were called into play, and then became the great agents in modifying the outlines of our earth to their fullest extent. When all the facts are taken into due consideration, it must therefore assuredly be admitted that the wonderful changes which now take place and have been effected in the physical geography of the world, have resulted from a combination of two great but most opposite agencies, the internal and external, igneous and aqueous, cataclysmic and uniformitarian, or by whatever other names they may respectively be called; and in considering this subject the student should always be prepared to admit what I have elsewhere insisted upon, that "all the phenomena of nature may be effected by a combination of more forces, and that the same identical phenomena may at times be the result of agencies totally different from those which at other times may have given rise to them."

The study of volcanic phenomena presents a wide and interesting field for exploration, for as yet our knowledge of the subject is lamentably defective; to follow it up, however, the student should work out a path for himself, taking advantage of every new means of research placed in his hands by the advance made by the collateral sciences, and steering clear of all schools or preconceived notions. Schools in science are what parties are in politics; the "follow-my-leader" style will not do in this age, for it does not permit of that perfect independence of thought absolutely requisite to insure success in the pursuit of science.

The study of science is the search after truth, but in this study the persevering and conscientious worker, although sure to attain good results in the end, must always bear in mind that his results, even when proved to be *truths*, are still only fragments of *the whole truth*, and that he therefore should guard himself against over-rating their value, *i.e.*, the extent of their application; since this can only be correctly estimated when these fragments have been found to fit accurately into their true place in the grand plan of Nature.

V.—The Granite-drift of Furness.

By Miss E. Hodgson.

(PLATE XV.)

THE dispersion of debris from the rocks of the Lake district towards the midland counties, is an old and well established fact. Between 1820 and 1850, we find it occupying the attention of such authors as Sedgwick, Phillips, Murchison, Agassiz, Buckland, Binney, Hopkins, and Mantell; and the present day observer may well be cautious in attempting to improve upon their initiatory labours. Special attention appears to have been directed to eastern and south-eastern lines of transport. The Shap granite was followed to every outpost; and the Cumberland erratics in the South Lancashire and Cheshire plains—and remoter valleys and uplands—received recognition in exhaustive memoirs.

The following notices are what immediately refer to North Lancashire, and the home-tracts of west, north-west and north Cumberland.

Professor Sedgwick remarks that,—"the plain bordering the hilly region on the north presents boulders and pebbles that have been transported across the Solway from Dumfriesshire:—in the transported rubbish capping a hill near Hayton Castle, four miles north-east of Maryport, there are large granite boulders resembling the rocks of the Criffel:—from St. Bees Head to the southern extremity of Cumberland, the coast region is covered by transported detritus of granite, porphyry, and greenstone, some of large size:—in Low Furness, similar phenomena are observable:—large blocks derived from the green-slate district are found on the granite hills between Bootle and Eskdale:—the syenite blocks of Carrock Fell can be traced through the valleys, and over the hills of the mid region, to the very foot of the parent rock."[1]

Dr. Buckland records "a remarkable assemblage of boulders of Criffel granite at Shawkbeck, between Carlisle and Cockermouth," and which he conceives may have been transported across the Solway Firth on floating masses of ice.[2]

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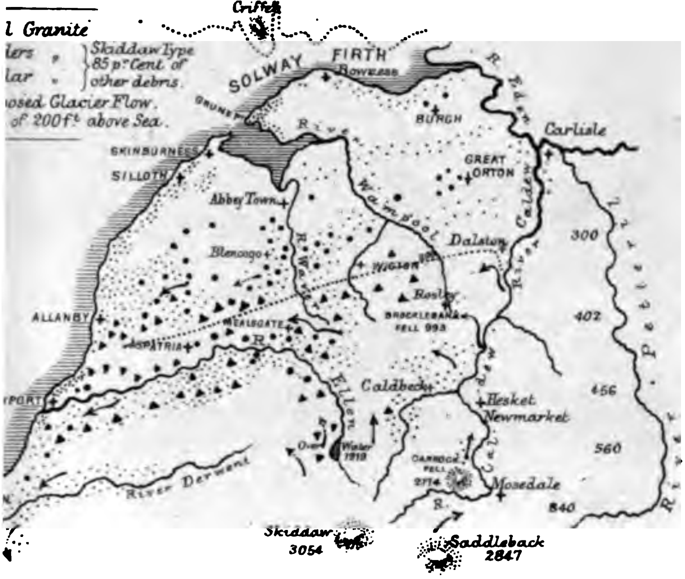
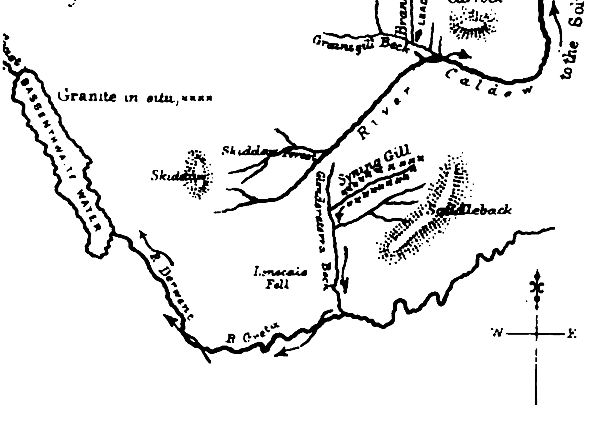
[1] De la Beche's Geological Manual, 1833. Extract from Professor Sedgwick's Paper in Ann. Phil., 1825.

[2] Proc. Geol. Soc. London, 1840.

ETCH MAP
CUMBERLAND.



SKETCH MAP
showing Syrung Gill and Brandy Gill. with direction of granite flow



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To illustrate Miss E. Hodgson's Paper on the Granite-drift of Furness.

Dr. Mantell says that "boulders of the granites, porphyries, syenites, and slaty series of the Cumberland mountains, are dispersed northwards towards Carlisle."[1]

Although long accustomed to see pebbles and boulders of granite among the beach gravels of Furness, it was with surprise that in the summer of 1865 I found them scattered in some profusion on the high fields of Hawcoat, a small hamlet celebrated for its quarries in Upper Permian Sandstone. As this place is situated only about one mile from the sea, which, setting in from the north, divides the Isle of Walney from the main land, it was easy to arrive at the conclusion that this must be a marine drift: and three interesting questions presented themselves—namely, what was its northern and eastern extension on Furness? what its greatest altitude? and whence the derivation of the pebbles?—to solve which I saw would be an arduous work of time, but not unachieveable in a country having no granite outbursts of its own. The result of my investigations, at once undertaken, was briefly given in the *North Lonsdale Magazine*, December, 1866. In that paper I showed, that being totally absent from the long line of hills and moors north and north-west of Ulverston: nowhere occurring about the Lakes of Coniston and Windermere, or in the valleys proceeding therefrom: absent also from the country at the head of the Duddon estuary: their extension was thus probably reduced to the line indicated by the north and south narrow vale stretching between Goldmire and Furness Abbey; further, that crossing what is now the Duddon estuary from the Haverigg shore in Cumberland, they had ascended the Furness ground at the opposite point of Scale Haws or a little to the north of it, and so had been thrown over the lands where first I noticed them. At Rampside it was shown that they entered into the deposits at the south cliff; thence they were followed as a shore drift towards the north arm of Morecambe, where they were found to thin out entirely. In like manner I believed them to have been swept up the Duddon to Foxfield; past Ireleth, Dunnerholme, Marsh-grange, Soutergate, Kirkby, Beckside, and Angerton, a reach of six or seven miles: but there I was in error. The material for the construction of the railroad that runs up the estuary close to high-water mark, was chiefly brought from the gravels near Furness Abbey. Higher than Dunnerholme, therefore, the cursory observer is deceived by this bank, which in more or less quantity has supplied the granite to the marsh. The mistake was very kindly pointed out to me by friends at Soutergate. As to the identification of the specimens with their parent rocks, I can only say that, having long possessed a fair collection from the Lake district, in which are granites of Eskdale, Kirkfell, Wast-water east screes, Skiddaw Forest, bed of Caldew, Syning-gill, Brandy-gill, and Shap, I conceived there might not be an insurmountable difficulty in the attempt; and although the list then given by me, on the authority of the late Mr. Joseph Graham, of Keswick, may have tended, by including a few syenite localities, to throw doubt on the authenticity of the true granites, yet the greater error perhaps would be to say that (with the exception of the last-named) the above are not present in our drift. I refer to this part of my former paper with hesitation, because of the opinion given to me by Professor Sedgwick; namely, that in the region where I have observed them, they are derived rather from the granite that ranges within the coast-line from Bootle to the foot of Wastwater. It is worthy of remark, however, that he assigns a further reach for the syenites, which he says "have come chiefly from the Buttermere and Ennerdale hills."

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[1] Wonders of Geology, 1848, vol. i., p. 212.

In the hope that the facts I have to record will be as acceptable to Professor Sedgwick as they are convincing to myself that the granite-drift of Furness is derived not only from the above-named nearest granite locality, but also from more distant points of Cumberland, I will take up the subject where I left it in 1866, and first describe the erratic clays of Hawcoat. In my former paper I was unable to say whether the granite blocks actually entered into these clays. That fact I have now ascertained. Indeed, judging from the quantity of granite found around the islands, there is little doubt but that the same deposit forms their upper stratum.

No very good section presents itself on the Hawcoat shore. Throughout the entire range of cliff, which, from the Hindpool steel works on the south to Scale Haws on the north, may be about four miles, the face is either wholly obscured by a vegetation of gorse, bramble, and sea-grass, or else clothed with it half-way down; while the lower portion is generally hid by that washed from above. There is no undermining, the waste from the top protects the base. In a few places, however, the land drainage has effected wide breaches which admit the spring tides, and here alone can traces of bedding be seen.

Section near Lodge Green.

a. Surface, sandy soil—one foot.
b. Reddish-brown sandy clay, with few pebbles, sand rather fine, clay not easily crushed between the fingers when dry—3 feet.
c. Very dark and also light ashy grey mixed clay with numerous small rounded pebbles including granite:—partly imbedded, but in places free from clay: this is harder than the above—6 inches.
d. Reddish-brown tenacious clay, almost free from pebbles; this is coated, as indeed is much of the clay in other parts of the cliff, with a glossy bluish film—3 feet 6 inches.
e. Beach gravels forming the base of Cliff-section.

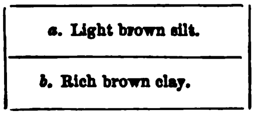
The height of the long escarpment may be from 8 to 30 feet, the thickness of deposits is somewhat less. The clays vary a little in colour (perhaps only as they are more or less damp), but the above description would apply pretty nearly to the whole, except that in the material washed down upon the lower face there is less plasticity; specimens do not indurate so much by drying, and have an uneven or breccia-like fracture.

The brick-pits inland afford somewhat more satisfactory information, especially that of Mr. Gradwell, situated within a mile from the cliff, between 50 and 75 feet elevation. Here the clays are 40 feet in depth, and rest upon a gravel bed which has been pierced in two places for water. Stratification is but faintly shown; but a sand and gravel layer about one foot thick had been worked through at 7 feet from the surface, having an incline of 3 or 4 inches in a yard towards the west. Unfortunately this bed was in water at the time of my visit. In the brick-pits still nearer to the cliff, the ascertained depth of clay is not so great, being only from 18 to 20 feet; while at Mr. Myerscough's, which is more round to the east, and about the same elevation, 17 feet is the thickness given.

The workable deposits in these pits are identical with *d.* in the section near Lodge Green. The colour, from being newly exposed, may be of a richer brown, and thus may contrast more beautifully with the variegated blue film. The latter is sometimes found lining very small cavities, when it assumes a sort of striated crystallisation, similar to what may sometimes be seen coating inferior blast-ore, or rather iron-impregnated carboniferous limestone. Mr. J. Cameron, F.C.S., obligingly describes this blue film as follows:—"A calcareous clay, containing silica, alumina, peroxide of iron, protoxide of iron, carbonate of lime, and a trace of magnesia."

In the last-named excavation, a much lighter brown and more silt-like bed reposes on the older, at an incline of 2 inches in a yard to the north-east.

SECTION AT MR. MYERSCOUGH'S PIT.



This, though a fine clay, is more sandy, less tenacious, and macerates readily in water; moreover, I believe it contains a very few frustules of Diatomaceæ, but they are too scarce and fragmentary to admit of easy determination. Upon these grounds it seems probable that *a.* is only the muddy subsoil of the salt-marsh that has here found its highest level.[1] No shells or other fossil remains have ever been seen by me, either inland or in the cliff face. There is brisk effervescence, but this may be caused by the limestone with which it is said to be pretty largely intermixed.

Granite, the only rock that could characterize this marine deposit on Furness, is obtained from all the clays in considerable quantity, and in some variety red and white: it varies also in size, as well as the other stones, from the pretty large cobble, or even boulder, down to little nests of its disintegrated minerals. Striation is so common as to be pointed out by the workmen.

[1] A good illustration of the rate at which in point of time these broken swards or salt-marshes will form along shores, is given in the fact that between Barrow and Rampside, at a point now protected by a railway embankment, there is an old iron ore shipping floor, which was used about 100 years ago. Over part of this floor soil has been laid, and many crops of potatoes grown; but in another place it underlies pebbles, sand, soil, and good herbage, to the thickness of 2 feet 3 or 4 inches. This shows in section, having been cut down again by tides; and from the base may be dug out to this day good samples of Stainton ore.

Leaving the precise point of entrance into North Lancashire, and the eastern extension thereupon, to be described in the sequel, I will now pass to the Cumberland side of the Duddon estuary. In the paper previously quoted, I noticed the enormous quantity of granite boulders and pebbles lying on the south Cumberland coast at Haverigg. Probably at no point on their line of travel are they more abundant, or accumulated in greater variety than here; and it ought to be conceded that the major part is no doubt derived from the range given by Professor Sedgwick. But although the valleys of the Irt, Mite, and Esk, have furnished large supplies to the general bulk, exhibiting many shades of difference, I venture to question whether there is ever an entire absence of the red, pink, or flesh-colour in the felspars. The character given by Mr. Otley in his notice of this rock is,—"a variety of granite with reddish felspar, and which from a deficiency of mica has sometimes been called syenite."[1] Professor Cumming distinguishes the Eskdale granite as "generally reddish, with a deficiency of mica, sometimes earthy in structure."[2] Mr. Binney recognizes the granite of Ravenglass as a "brownish-grey granite, with a light pinkish-white felspar."[3] My own specimen of the granite of Eskdale might also be described as a brownish-grey granite, the felspar white to pale flesh-colour, in places pink; some of the crystals dull and "earthy;" quartz brownish-white; mica grey, and sparingly disseminated.

Working northward from Haverigg, I found, during last summer, a few small reddish granite pebbles, both sub-angular and rounded, in the higher forks of the Whicham valley, to the north of Millom Park, at 135 feet elevation. These granite pebbles were associated with others of a brownish-red sandstone, all of them, even the smallest, displaying numerous thin laminæ. Now these latter pebbles must belong to the *lower part* of the Upper Permian Sandstones, a shown in section at Barrowmouth, St. Bees Head.[4]

From an inspection of nearly a hundred stones picked up on the rocky coast at St. Bees, a different type of granite is seen to preponderate there. Instead of a brownish-grey, this might be called a black and white granite: for there is an abundance of dark mica, with white felspar, and white quartz: and it also varies considerably, according to the proportions of these minerals.

The same thing is repeated on the Harrington, Workington, and Maryport shores: beautiful white crystals of felspar, white to light-brown quartz, and dark, nearly black, mica; identical, as it seems to me, with the "Granite which forms the base of Skiddaw."

Mr. W. Dickinson, of Thorncroft, Workington, very kindly places at my disposal the result of some of his observations over a district which he has noticed, with an eye to its geology, for a great many years. Alluding to the inland dispersion of granite, he says, "Further down the valley "(Ennerdale) "boulders of grey granite are found distributed over a wide range, (but I think not on the elevated parts,) of Kelton, Kinniside, Salter and Eskett, Frizington, Cleator, Hensingham, and over great part of the townships abutting on the sea. Indeed, the distribution is very general from the base of the mountains westward to the coast; but least on the limestone ridges where raised above the ordinary level of the country. In a western direction from the base of Skiddaw, boulders and also irregular shaped fragments of granite are found spread over a large district to the sea; and the angular masses are not so widely spread, but are more in a broad line towards the neighbourhood of Allonby. Except where the shore is of sand, the whole line of the Cumberland coast is strewn with granite, mostly the grey, intermixed with a few small bits of a beautiful red kind, resembling or even more beautiful than the Aberdeen red granite. The heaps of broken stone on the highway sides give a good idea of the hard produce, when the collections have been taken from the fields. In these I have noticed the grey granite as very general, but I have nowhere found the red inland. Wherever the plough has been at work, or drains have been cut, granite boulders have almost invariably been turned out."[1]

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[1] Jonathan Otley's Descriptive Guide to the English Lakes, eighth edition.

[2] Rev. Prof. J. G. Cumming, Geology of Cumberland and Westmoreland.

[3] Mr. Binney, MS.

[4] See a description by Mr. Binney of the St. Bees Sandstone, Mems. of the Lit. and Phil. Soc., Manchester, vol. ii., 3rd series. "Further Observations on the Carb. Perm. and Triassic Strata of Cumberland and Dumfries."

The Rev. T. Ellwood, Rector of Torver, obliges me with a short descriptive sketch of the north shore of the county, with which he is well acquainted. "The coast from near Allonby to Silloth, a distance of six or seven miles, consists beyond the sea-line of hills of sand, many of them of a considerable height. At the base of these, in some places half a mile and even more from high-water mark, are large beds of pebbles. Layers of pebbles crop out also at various altitudes in the hills themselves. Proceeding to the north-east of Silloth, the aspect of the coast changes. Almost immediately after leaving the town, we have a level bed of sand, overgrown with bent; and although isolated swells of the former character occur here and there, yet to Skinburness, a further distance of two miles, it is chiefly flat sand, in which, however, pebbles are to be found. From Skinburness to the Grune Point, about a mile and a half, it becomes more marshy, though there is still abundance of shingle on the beach.

"The Grune has many pebbles. It forms the western point of that estuary by which the rivers Wampool and Waver join the Solway. I never found deposits of pebbles in this estuary. The Solway itself, from Bowness, has extensive marshes spreading along its southern shores."[2]

Through the kindness of Mr. Ellwood and his friend, Mr. Smith, of Abbey Town, near Silloth, I am favoured with a collection of the beach granite. That is not however the preponderating rock debris there, as it is further south. According to Mr. Smith, the most abundant is,—1st. A dark blue-grey stone used for paving; 2nd. Granite; 3rd. White flint; 4th. Dark red or brown sandstone;

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[1] Mr. W. Dickinson, MS.

[2] Rev. T. Ellwood, MS.

5th. A few light grey, or whitish brown sandstones. Of the granites, the white or Skiddaw kind ("grey" of Mr. Dickinson) appears to prevail. There is also a very dark iron-grey variety, with a good deal of black and grey mica, brown quartz, and brown felspar. A third probably represents that alluded to by Mr. Dickinson. Of this I have only one specimen: a sub-angular and glaciated one, 2½ inches in its longest diameter. The fractured faces of the stone are extremely beautiful, bearing a resemblance to the Aberdeen granite, but perhaps more equal in the proportions of its minerals; the felspar is flesh-colour to brownish red, the quartz milk-white, and the mica grey to black. The colour of the granite is derived from the felspar.

To geologists who distinguish glacier-moraines from sea-arranged deposits, the foregoing two descriptions must tell a plain tale: indeed, guided by those excellent aids, the contoured ordnance maps, I had already suggested[1] to another obliging investigator (Mr. J. Eccleston, of Carlisle), both the elevation and line of western sweep, upon which such remnants of north Cumberland glaciers might possibly be seen, and it was gratifying to find those surmises apparently confirmed by the independent and prior researches of Mr. Dickinson.

Mr. Eccleston commenced by examining the channels of the Caldew and the Petterill, and the ground to the east of both; but as the Skiddaw and neighbouring granite region must be the main source of supply, I propose to make the former river the eastern limit of inquiry, only stating that there is a good deal of granite in the line of the Petterill.

The Caldew rises near the summit of Skiddaw, and after a tortuous course northward of about 30 miles, falls into the Eden at Carlisle. Now it can by no means be affirmed that this stream, notorious as it is for its furious floods, could carry a piece of granite from Skiddaw to Carlisle; and that the same piece could move on down the Eden and Solway, and ultimately arrive at Morecambe Bay, or the west shore of the Isle of Walney. Granite is sometimes sparingly found at Carlisle, but it is believed to be for the most part destroyed before reaching that city. To test the wearing force of the water, experiments have been made of anchoring in it squared blocks from marble works, when in two months their shape would be reduced to an oval, every angle effectually taken off. Even higher up about Dalston, where granite is less scarce, it is matter for doubt whether it has travelled far, and not rather been washed out of the thick deposits at the sides. A considerable quantity of the Brandy-gill granite[2] (Carrock) is found at the above distance from the mountains, which cannot be less than 18 miles, with a fall of about 1,000 feet. From the nature of this specimen, with its abundant flakes of mica, and its general softness, being fully as easy to break as loaf sugar, it seems much safer to assume that an unusual number of fragments might be detached at any point on the river from some disengaged boulder lately brought under its influence.

[1] October 18, 1869.

[2] Identified as such by Mr. B. M. Wright, Great Russell Street.

It is not, however, to the present waters of either sea or river that I am restricted in an attempt to prove remoter derivation than the south-western valleys for the Furness erratics. They are inadequate to the task; for although granite pebbles in the north of Morecambe certainly evidence a "travelling of beach," yet 18 or 20 miles in a quiet estuary with very few rocks, can be nothing in comparison with nearly 100 miles of sea coast, part of it rock-bound. As in the river, so upon the beach; the waters feed on the old land-deposits, and rarely perhaps convey them so far from their starting place as at first sight might be imagined.

The Caldew pebbles have every significance when taken in connection with perpetual snow-fields and glaciers, of which they undoubtedly are some of the relics. The Brandy-gill granite, for instance, that in the present stream is rarely seen lower than Dalston, was picked up by my sister in Morecambe, between Bardsea and Ulverston, 140 miles from its parent rock. Mr. Wright, of Great Russell Street, labels this:—"Granite, containing a great quantity of felspar, *Brandy-gill, Carrock*;" and it is worthy of note, that it is the very same specimen for which Mr. Joseph Graham gave that locality in 1866.[1] The mica in both this and the Caldew pebble, is a beautiful pearly white; the preponderance of quartz in the one and of felspar in the other appearing to constitute the main difference. As Mr. Wright is thoroughly well acquainted with the Carrock rocks and minerals, and with the Brandy-gill locality, no reasonable doubt can remain as to the correct identification of this interesting traveller.

Among other granite debris in the Caldew, that of Skiddaw may easily be recognized, especially sheddings from the compact kind of rock in the river's bed near Mosedale. Mr. Otley notices it thus:—"A rock of granite, composed of quartz, white felspar, and black mica, may be seen denuded in the bed of the river Caldew, on the north-east side of Skiddaw."[2] In some of the detritus sent me, the colour is darker, with a tendency to brownness on the faces of joints, as if from decomposition or segregation of some chemical constituent.

Sufficient may have been adduced to show that this granitic tract has undergone denudation in the first place towards the north; and then, the very best evidence perhaps of an old divergence westward, at a point 2654 feet below the greatest altitudes, lies in the fact[3] that numerous huge boulders of Carrock syenite are scattered about Rosley, three miles out of the river course, and 400 feet above the present sea-level. It is possible that all traces of actual glacier descent into the Solway may now be covered up on the Cumberland side; but as glaciers in the Alps fall 4000 feet below the line of perpetual snow, surely, even after allowing for subsequent atmospheric waste and lowering of the heights, the intervening vertical depth between these heights and the present sea-line, is not too great to assign to the English glacier, if ever there was one. I infer, therefore, with all due deference to the opinion of those who have assisted me, and to that of others, that the boulders at Rosley, and the angular granite previously noticed, indicate the higher or more southerly edge of a glacier, which, meeting in the plains of the Solway, like descents from the Scottish slopes, pressed out westward to the Irish Sea.[1]

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[1] See my paper in the North Lonsdale Magazine, p. 235.

[2] Otley's Guide to the Lakes, p. 145.

[3] On the authority of Mr. J. Eccleston.

Mr. Binney, in one of his Memoirs on the Permian Beds of the north-west of England,[2] incidentally alludes to the thick covering of drift between Curthwaite and Howrigg (190 to 300 feet elevation): and he informs me that, with the exception of the valley gravels, he saw little sand or gravel capping the till;[3] so most likely it is true moraine matter down to a low level there, as in Furness. Almost the entire country, namely from Hesket Newmarket towards Rosley, the neighbourhoods of Wigton, Abbey Town, Blencogo, and Mealsgate, have been traversed by Mr. Eccleston, and that observer attests to the prevalence of the Skiddaw type of granite, which he believes may form in places about 85 per cent. of the other debris. He mentions it as singular that there is so little limestone, but the trend westward might obviate that. In railway cuttings near Aspatria, limestone boulders are plentiful; and, according to Mr. Hodgson, of that place, they are almost invariably covered with deep glacial indentations.[4]

Now although detritus from the granite of Criffel, on the opposite coast of the Solway, may possibly be undistinguishable from that of Skiddaw; and although there is in the latter an apparent resemblance, even to some of the Irish granite; yet the foregoing should tend to prove, as far as can be without analyses, that Cumberland has furnished, in the main, its own granite drift. It may be surmised that drift from more northern sources would pass further west.

With regard to the granite of Syning-gill, between Saddleback and Skiddaw, briefly noticed both by Mr. Otley and Professor Sedgwick,[5] that rock has been shed southward down the Glenderaterra ravine.[6] This highest seen granite must occur in considerable mass, being lately quarried for building stone, of which any quantity, it is said, can be got; and it would seem also to be accompanied by rocks of a gneissose character, as in a fine hand-specimen obtained from the late Mr. Charles Wright, of Keswick, the granite and "gneiss" are shown in junction, and the specimen is so labelled: with, however, the addition "very rare." There is distinct lamination in the dark-grey "gneiss" half of the specimen, and the parallelism is extended, though very slightly, into the granite. The "gneiss" appears to be identical with another I have from the same collector, labelled "Gneiss from Skiddaw Crags." A third from Skiddaw Forest he names "Hornblende Gneiss."

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[1] See Mr. Binney's paper in Trans. Lit. and Phil. Soc., Manch., vol. x., 1852, where he ascribes the drift-deposits near Blackpool to the conjoint action of Cumberland glaciers and icebergs, the former "extending from the mountain-sides *down into the sea*." The grand glaciation on what is now Morecambe Bay, between Bardsey and Aldingham, which I noticed in the "Geologist," 1864, and again more fully described in the N. L. Mag., 1866, is about 3,200 feet below our greatest altitudes.

[2] Trans. Lit. and Phil. Soc., Manchester, vol. xiv., 1857.

[3] Mr. Binney, MS.

[4] Messrs. Eccleston and Hodgson, MSS. According to the former, the fellsides and outside pastures are so thickly strewn with boulders that they give immense trouble to the agriculturists, who in general prefer burying them below plough-reach to any other mode of extirpation.

[5] "Letters" appended to Wordsworth's Guide to the Lakes.

[6] The exact position of Syning-gill was courteously pointed out to me by Mr. J. Crozier, of Riddings, Threlkeld; as was also that of Brandy-gill, a branch of Grainsgill, near Carrock Fell. See Sketch Map, reduced from the one-inch Ordnance sheet.

Mr. Dickinson informs me he first saw the Glenderaterra or Syning-gill granite when in company with Mr. Otley long years ago. He considers that, though no great quantity of its recent detritus may be visible in that steep-sided pass, there is sufficient in the drift along the base of Lonscale Fell (see Sketch Map) and round the south-western foot of Skiddaw, to identify the apparent source, and the character of it, with the Glenderaterra granite. Along Bassenthwaite-side boulders occur resembling the above associated metamorphic rocks; while those of granite extend away to the north-west of the mountain, and thence mingle with the general coastward flow.

Thus, in delineating the downward passage of this alpine debris towards the lowlands by the preserving and motive power of ice, it becomes obvious that no difficulty or obstacle of any kind stands in the way of an attempt to track even the most distant erratics back to their source.

Tile-clays.—"A considerable area of the western part of the county supplies patches of tile-clays. They are at Threlkeld, Keswick, Isel, Bassenthwaite, Bolton, Westward, Parkgate near Wigton, Seaton, Mosser (exhausted), Cockermouth, Winscales, Dean Moor, Arlecdon, Sandwith, Bigrigg (exhausted), Drigg, Bootle, Sylecroft, and Holborn Hill. There are many intermediate clay-fields, but too shallow to be worked with profit. They are very various in colour and tenacity; yellow, blue, red, brown, grey, etc.; unstratified in general; some within a few inches of the surface, others feet or yards below. Many differences in colour and texture are found in the same pit, with consequently great variation in quality. Some have layers of sand in parts, few have gravel. Some are more or less intermixed with rounded gravel; others penetrated to some feet in depth by decayed root fibres. These clays produce drain-tiles, pipes, and common bricks, and almost invariably burn to a red colour, whilst the fire clays of the Coal-measures burn to shades of yellow. No shells or other fossil-remains are known to occur in them.

"The sea is making great inroads on the Boulder-clay of the Workington coast. Within threescore years, nearly fifty acres have been washed away. An under layer of fine blue clay may be seen a few hundred yards to the south-west of the cliffs there; it contains the remains of a submerged forest. A similar forest is visible a little southward of St. Bees during low tides."[1]

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[1] Mr. Dickinson, MS.

In the old denudation then of north and western Cumberland, and that of its former westerly extended land surface, we see the origin of the erratic clays and granites of Furness.

It now only remains to show their extreme northern point, and their very limited eastern extension over that district. Their altitude I have not found to exceed that given in the "North Lonsdale Magazine," namely, 275 feet,[1] and it is impossible to think that laden icebergs drifted by easterly currents, would not have deposited their freight on more easterly ground, had the land been submerged beyond, or much beyond that extent. For example, sink Black Combe well under water; there would be no hindrance to their passage over its northern shoulder, over the Ireleth slate hills, and over Birkrigg-common, where not a pebble of granite exists. On the contrary, it might seem that the mountain had given a slight *westerly deviation* to the currents, as the passage indicated would have been straighter.

The most northerly point at which the pebbles take Lancashire ground (within the salt-marsh) is close below a farm called Greenscow, three miles south of Soutergate, and less than half a mile north of Scale Haws—my 1866 point of ascent. This is in an E.S.E. direction from Hodbarrow Point, from which Greenscow is now separated by the full breadth of the present estuary, 2½ miles. From this place, where no profile is exhibited available for a section, they are seen to mingle very sparingly in the loose debris of the green slates, where that is shown in the roadside cutting. This road, a new one, gradually rises and passes along the face of the Greenscow Crags, on the southern flanks of High Haume. The granites may be extracted, here one and there one, both red and white, up to Low Haume,[2] between 250 and 275 feet elevation. I have examined the higher ground bordering the road for them, but without success. They are again seen in the deposits near to Elliscales, where they are more difficult of removal.[3] At St. Mary's Bank, Dalton, three quarters of a mile directly south of the latter place, there is a thick bed of (apparently) river gravel, exposed in a stable yard near the Cemetery. Here there are no granites, nor are there any to be found on the lands still further south.

These investigations, renewed at intervals since 1866, enable me to discover that the granites have taken a circuitous sweep round two small hills: Housethwaite Hill and Haggs Hill, their base being on the same level with the Goldmire valley; and that, regaining the same valley, their course is ruled by it south-westward to the shore. Thus they have nowhere made an eastern divergence from my former line exceeding half a mile.

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[1] It may be a question whether the true iceberg deposit reaches more than half that height.

[2] At Low Haume, there is, abutting against the limestone of Housethwaite hill, a curious mass of cemented angular limestone pebbles, containing Carboniferous limestone fossils This was first seen by me many years ago. Mr. Talbot Aveline calls it *cemented screes*. In hand-specimens it resembles the breccia of St. Helens, on the south of the same hill; and also that at Dalton; both referred by Sir R. I. Murchison and Prof. Harkness to Lower Permian strata. Quart. Journ. Geol. Soc. Lond., vol. xx., 1864. In places, the Low Haume crab-rock coats the hill-side in varying thickness; but to the east or north-east, the limestone appears to have been quarried back at some time, leaving the breccia standing in great natural buttresses, twelve yards high.

[3] There are no boulders, properly so called, along this road. I observed *two* cobble stones: one, near Greenscow, on low ground, might measure 7 or 8 inches in diameter; the other, built into a wall at Low Haume, would measure less.

At Ireleth, the next village north of Greenscow, granite is not uncommon in the roads, but I am assured by the farmers that it is thrown from carts conveying shore sand, which is largely used throughout the country for horticultural, building, and other purposes. This at once accounts for the presence and destroys the value of any *isolated surface*-pebble wherever it may be found.

In conclusion, while recognizing these evidences of the submergence of West Furness, it by no means follows that the eastern ground has been depressed to the same extent. It must be borne in mind that at the period when icebergs floated past on their way south, Furness was not a peninsula; her southern and eastern escarpments, whether of erratic or still older deposits, attest the fact. In short, that which is seen in miniature at Lodge Green, in the Hawcoat cliffs, is simply repeated on a larger scale :—the land drainage has cut wide breaches, which have admitted the sea.

Again, at Ulverston, the sea's influx up the drainage courses can be no evidence of general depression; as while sea-arranged gravels, with some few marine shells, reach nearly 100 feet elevation, yet half a mile out of these courses it seems to be true untouched moraine matter down to between 30 and 25 feet, as shown by some late deep cuttings.

On the other hand, shore-lines are sometimes artificial. In the memory of old inhabitants, small traders rode up our serpentinous Carter Pool fully half a mile within the Ordnance high-water mark. Small pieces of local evidence like this, ought surely to be taken into consideration in any attempt to correlate these deposits.

Cavendish Street, Ulverston,
1st March, 1870.

NOTICES OF MEMOIRS.

RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

Vol. III. Part 1. February, 1870.

This Part of the Records contains the *Annual Report of the Geological Survey of India, and of the Museum of Geology, Calcutta, for the year* 1869. By Dr. Oldham, F.R.S., Director.

Besides the absence from India of Mr. W. T. Blanford, who for ten months of this period was busily engaged in the preparation of his Report on the Geology and Natural History of Abyssinia, the temporary losses of two officers away on furlough, of one from illness (sunstroke), the Survey further suffered, during the year, the loss by death, in April, of Mr. Charles Oldham, Deputy Superintendent for Madras. Notwithstanding these drawbacks, much progress has been made in the Survey, and a great deal of valuable geological information obtained from various parts of the country.

Attention was early drawn to a serious earthquake which was felt at Cachar and Sylhet, on the 10th of January, 1869; the evidence connected with which was examined into by Dr. Oldham, and briefly laid before the Asiatic Society of Bengal. A further report of the effects of this earthquake is in progress.

As few accurate records exist of the earthquake shocks felt in the country, Dr. Oldham has been led to prepare a catalogue of Indian earthquakes, and, aware of the difficulty attending the compilation by a single individual, he solicits the contribution of facts from others who have paid attention to the subject.

In the Central Provinces, Chanda and Berar, explorations by boring have taken place to test the continuity of the beds of coal which the river Wurdah has exposed in one or two places, and also to prove the nature, thickness, and contents of the coal-bearing formation generally.

This method is rendered the more necessary in this district from the fact that the rocks are, except at distant intervals, concealed by a thick covering of clays.

The presence of coal has been satisfactorily determined, by boring, at Telewassa,—41 ft. 7 in. of coal have been determined here, in a total depth of 138 ft.,—and also near the village of Nokora.

The results, so far as the explorations have been carried, point to the general continuity of the coals on a fixed horizon in the lower sandstones of the Barakar group.

Well-sinking has been attempted at Umballa—a large station which suffered much from insufficiency in supply of water. Mr. Medlicott, from an acquaintance with the country, urged this method of obtaining the required article, and the very first trial confirmed the justice of his expectations.

Comparisons have been instituted by Mr. Medlicott between the several series of sandstones, etc., associated with the coal in Bengal, and those in Central India.

The vast extension and great constancy in mineral character of the Talchir rocks (which form the base of the great coal-bearing series) has been more fully established, and the dying-out of the beds in passing to the west has received further support. The entire group of the Coal-formation, which in the east gives five well-marked subdivisions (in ascending order, Talchir, Barakar, Ironstone shales, Ranigunj, and Panchet), becomes, at a short distance to the west, only a three-fold series, comprising the Talchir, Barakar, and Panchet subdivisions.

Mr. Medlicott has also brought forward additional proofs to show that, on the large scale, the present limits of these Coal-measures coincide approximately with the original limits of deposition, and are not the result of faulting, or even mainly of denudation.

Dr. Oldham re-states his opinion (announced by him at the meeting of the British Association in 1867) that the great drainage basins of India were on the large scale marked out, and existed (as drainage basins) at the enormously distant period which marked the commencement of the deposition of this great plant-bearing series. In this point of view, local variations in the lithological type, and local variations in the thickness of the groups, and even their occurrence, or non-occurrence, are only necessary consequences of the mode and limits of formation.

The work carried on in Madras, Bombay, and Burmah, is briefly alluded to.

In regard to the Museum, it may be mentioned that during the year more than 20,000 specimens have passed through the hands of the Curator and his Assistant, and have been catalogued for reference; but many of these had to be packed up again, there being no place to keep them otherwise.

An Index-map is appended to this Report, showing roughly the present state of progress of the Geological Survey of India.

REVIEWS.

THE ORNITHOSAURIA: an Elementary Study of the Bones of Pterodactyles, made from Fossil Remains found in the Cambridge Upper Greensand, and arranged in the Woodwardian Museum of the University of Cambridge. By H. G. SEELEY. Cambridge: Deighton, Bell, & Co., 1870.

THIS volume is the second of a series of "Indexes and Memoirs" descriptive of the Palæontological remains in the Woodwardian Museum, in course of preparation by Mr. Seeley, and has followed closely upon his less pretentious, but useful, "Index" to the same collection published last year.[1] Although professing to be only an "elementary study of the bones of Pterodactyles," from a very limited geographical area, and as limited a geological era, yet the author has gathered and put together in a condensed form a large amount of information on the subject of which he treats, derived from many sources and from his own observations.

The work may be divided into four parts: 1st, the Introduction; 2nd, the Osteological details, in which the general character of each bone of this group of animals is fully described, without regard to genus or species; 3rd, their Classification; and, 4th, a Synopsis of the Species in the Woodwardian Museum.

The author enumerates, in the Introduction to his work, the material which he has had at his disposal; it comprised a series of more than 500 bones in one collection, and about 400 in another, and he computes that they could not have "pertained to fewer than 150 individuals—a remarkable quantity from so small an area, and a striking proof of the numbers in which this Order of Vertebrates abounded when this deposit was being formed. All the bones from the Cambridge Greensand are more or less broken, but their articulating surfaces are in general well preserved and easily defined; the soft marl in which they were embedded having preserved them from being flattened or distorted.

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[1] See GEOL. MAG., Vol. VII., p. 34.

Among the earliest collectors of these interesting remains were Mr. James Carter, Prof. G. D. Liveing, Rev. H. G. Day, Rev. T. G. Bonney, and Prof. Sedgwick; the last three have deposited their collections in the Museum of the University.

The literature of the Cambridge Pterodactyles is confined to memoirs by Prof. Owen, published by the Palæontographical Society in 1851, 1859, 1860; and by Mr. Seeley in some memoirs communicated to the Cambridge Philosophical Society in 1864, 1868, 1869; a paper read at the British Association in 1864, and two papers in the Annals of Natural History for 1859 and 1860; and in all he claims a position for these animals as a "separate sub-class," having greater affinities to birds than to reptiles; and this he strongly maintains, with much logical reasoning, from his point of view, throughout the present volume.

With respect to the organization of the Pterodactyles, Mr. Seeley remarks, "that nearly every writer on Pterodactyles, who has expressed any opinion at all, has formed an estimate of his own of their organization. They have been assigned to almost all possible positions in the vertebral province by great anatomists who all had before them very similar materials;" and he has given us an interesting summary of the diverse views held by these various writers, from which we gather that Sœmmering regarded the Pterodactyles as a kind of bat, but he had a suspicion, from certain characters of the head and feet, that it was intermediate between mammals and birds. Oken at first thought that the animal was mammalian, but afterwards he was inclined to consider it reptilian. Wagler saw some resemblance in the jaws and back part of the skull to those of dolphins; whilst Goldfuss, anticipating the evolutionists of to-day, "sees in Pterodactyle an indication of the course that nature took in changing the reptilian organization to that of birds and mammals." Wagner is convinced that the Pterodactyles are Amphibians approximating to the Saurians. Quenstedt sees evidence that the animal was able to walk upright, even more so than birds; whilst Burmeister entirely rejects these opinions of Quenstedt. These are only a few examples of the many points of structure, affinity, and habits upon which comparative anatomists differ from each other, showing how difficult it has been to define the position in nature of these curiously-formed creatures. The late accomplished anatomist and palæontologist, Herman von Meyer, who has done so much in his various memoirs towards elucidating the anatomy of this interesting order of extinct animals, arrives, after an elaborate comparison of their remains with those of other classes of vertebrates, at the conclusion that they are reptiles, though admitting the fact of their possessing many affinities with birds. This conclusion Mr. Seeley combats with some force. When Prof. Huxley finds in the skeleton of the huge Dinosaurs certain resemblances of structure to birds, it is only reasonable to expect that still greater resemblances to birds would be found in the *Pterodactylia*, which, like the class *Aves*, were equally well adapted for aerial locomotion. In his recently published monograph on the Pterodactyles of the Lias, Prof. Owen holds that they are Saurians. So that the weight of authority is at present in favour of retaining them in the class Reptilia. This our author contends is an error.

The Osteological portion, where each bone is separately and fully described and compared with its analogue in mammal, bird, and reptile, is too technical to do more than refer to, as a valuable contribution to the anatomy of these creatures.

Whether they were hot or cold-blooded, is still a moot question. The former view Mr. Seeley emphatically maintains, founding his opinion chiefly on the form of the brain, as evidenced by its case, "which proves the Pterodactyle to have had a brain undistinguishable from that of a bird;" whilst Prof. Owen as emphatically maintains, from other characters, that it was cold-blooded.

In the author's "summing up," various systems of classification of the extinct Reptilia are reviewed, and considered as unsatisfactory by Mr. Seeley, in the absence of any knowledge of the brain in some of the orders; and he thinks that the "Reptilia of the Palæontologist is a vast and provisional group, ever acquiring new characters, to which no diagnosis can be applied."

Remains of twenty-five species of *Ornithocheirus* (Seeley) are preserved in the Museum. Twenty of these are new and now first described. Some attained a large size, having had an expanse ot wing of about 20 feet; and the smallest not less than a fourth as large. The head of one is 15 inches and the neck 9 inches, respectively, in length.

The text is illustrated by twelve lithographic plates, containing nearly 200 figures of the bones described, but the printing is too black, and the drawing betrays the hand of an amateur in need of a master's direction.

The book itself is worthy of perusal and careful study, whether we coincide with or dissent from the deductions of the author; and the thanks of palæontologists are due to Prof. Sedgwick, at whose expense it has been prepared, the cost of the printing only having been defrayed out of the funds of the Syndics of the University Press.

REPORTS AND PROCEEDINGS.

GEOLOGICAL SOCIETY OF LONDON.—May 25th, 1870.—Joseph Prestwich, Esq., F.R.S., President, in the chair. The following communications were read:—

1. "Contributions to a Knowledge of the Newer Tertiaries of Suffolk and their Fauna." By E. Ray Lankester, Esq., B.A. Communicated by Prof. Huxley.

1. *The Suffolk Bone-bed and the Norfolk Stone-bed.*—The author pointed out that the recognition of the distinction of these two deposits from the overlying shelly Crags was an important step in

the determination of the history of these beds. He combated the notion that the Bone-bed and Stone-bed were identical in their contents; and especially dwelt on the differences of the mammalian fauna found in the two. The late Dr. Falconer's views, hitherto prevalent, consisting in regarding the fauna of the Suffolk Bone-bed, Norfolk Stone-bed, and Forest-bed as all of one and the same history and extent, he most strongly opposed. *Rhinoceros Schleiermacheri*, *Tapirus priscus*, *Hipparion*, *Hyæna antiqua*, and a well-defined Miocene *Mastodon* (Fauna 1), had been found in the Bone-bed below the Suffolk Crag; the first three in some abundance, but never in the Stone-bed or Forest-bed of Norfolk. They belonged to a different fauna from that indicated by the other mammals common to the Bone-bed and Stone-bed (Fauna 2), viz., *Mastodon Arvernensis*, *Equus* sp., and certain forms of *Cervus* (studied by Mr. Boyd Dawkins). On the other hand, the *Elephas meridionalis* (Fauna 3), occurring in the Norfolk Stone-bed and in the Forest-bed, had *never* been found in the Suffolk Bone-bed. Mr. Lankester suggested that the association of the first two of these three groups of mammals in Suffolk, and of the second two in Norfolk, might be explained by the hypothesis that they succeeded one another in time, the first (late Miocene) being confined to Suffolk, and dating from before the Diestien period, since he had obtained a Mastodon tooth of the *M. tapiroides* form inclosed in a Diestien box-stone; the third having existed in Norfolk at a period subsequent to the Coralline Crag, but before the Norwich Crag was deposited, chiefly represented in the lower part of the Forest-bed, but also in the Stone-bed, whilst the second group of mammals had existed in both areas at an intermediate period. Mr. Lankester maintained that this was the explanation suited to the facts as they at present stand, and considered that the question was not one to be shirked. All geological inferences from palæontology rest on what is called negative evidence, and hypotheses must be used in investigation. It was shown that the London clay had contributed very little indeed to the list of mammalian remains found in the Suffolk Bone-bed. Six teeth of *Coryphodon* and four fragments of *Hyracotherium* were all that could be found in the various collections.

2. *The Suffolk Box-stones.*—These nodules the author had previously described as being the remains of a deposit approximately similar to the Diestien or Black Crag of Antwerp, which had preceded the Coralline Crag in Suffolk. An enlarged list of remains of Mollusca from these nodules was given, and a large series of specimens collected by the author was presented to the Society's Museum. It was from the Diestien beds, containing *Conus Dujardinii*, *Voluta aurisleporis*, *Isocardia lunulata*, etc., that the Cetacean remains of the Suffolk Bone-bed were derived.

3. *A new Ziphioid Cetacean from the Bone-bed of Suffolk.*—The rostrum described in detail was in the collection of the Ipswich Museum. It indicated a Cetacean of the genus *Choneziphius*, differing from *C. planirostris* of Cuvier and *C. Cuvieri* (of Prof. Owen's recent

Monograph), in having a solid projecting apex to the rostrum, and no trace of a bifid structure. Mr. Lankester had recently carefully examined Cuvier's original specimens in Paris, and suggested that possibly *Choneziphius planirostris*, *C. Cuvieri*, this and two other Antwerp specimens, are but varieties of one species, according to age and sex. This form was, however, noted as *Choneziphius Packardi*.

4. *A new Mastodon from the Suffolk Bone-bed.*—A Mastodon tooth, inclosed in Diestien matrix, and indicating a form with open and clear valleys, had been obtained by Mr. Baker, of Woodbridge, and noticed by the author a year ago. He had since, in various collections, detected eight other fragments of a Mastodon, very distinct from *M. Arvernensis* and approaching *M. tapiroides*. Possibly the fragments indicated more than one such distinct species. The condition of these specimens and other evidence tended to associate them with the *Rhinoceros Schleiermacheri*, *Hipparion*, etc., forming a fauna quite distinct from and older than that which was indicated by *Mastodon Arvernensis*.

5. *List of Mammalian Fossils of the Suffolk Bone-bed, with reference to Collections containing them, and Number of Specimens.*—The object of this list was to furnish an idea of the actual and relative abundance of the various mammalia, and to afford those interested in the matter information as to the much scattered materials in private collections.

Discussion.—Mr. Boyd Dawkins had arrived at a different conclusion from the author, though the discoveries recorded in works on palæontology showed a marked difference between the Suffolk and Norfolk Crag Faunas, such as was not borne out by an examination of collections. He considered that the forms of Ruminants showed a contemporaneity between them. The supposed *Cervus dicranoceros* of Owen was, in fact, another form of deer, which was common to the base of both the Suffolk and Norfolk Crags. The *Elephas meridionalis* and *Mastodon Arvernensis* had been found side by side in Norfolk, at Epplesheim, and in the Val d' Arno, and were, therefore, probably contemporary. The different lithological character in the two counties was probably due to the different nature of the underlying beds.

Sir Charles Lyell was much struck with the perfect identity between the boxstones of Suffolk and some exceptional Antwerp beds which he had seen at Berchem, and considered that this was sufficient to prove they belonged to the same deposit. He thought that the area between Belgium and England might have contained a large number of terrestrial beds, which eventually left a certain number of their contents to be mingled together in the lower beds of the later marine deposits.

The Rev. J. Gunn produced from the Red Crag at Waldringfield a portion of the tooth of *Elephas meridionalis*. He insisted on the complex nature of the forest-beds, which consisted of two parts: the lower, estuarine, containing *E. meridionalis* and extinct forms of deer; and the upper, terrestrial, with remains of *E. antiquus* and much altered forms of *E. meridionalis*, approaching, in some respects, *E. primigenius*.

Prof. Ramsay pointed out the necessity of there being a great intermixture of remains of various characters and ages in such deposits as the Crag. If, for instance, Auvergne, which had not been submerged since Eocene times, were now depressed below the sea, future geologists might find the remains of Miocene animals intermingled with those of the present day.

Mr. Ray Lankester, in reply, contended that the Miocene forms of *Hipparion*, *Rhinoceros Schleiermacheri*, the trilophodont Mastodon, and other Miocene animals, had never been found in the Norfolk beds; while *Elephas meridionalis* had not been found in those of Suffolk. His conclusions were based on long study of collections, and differed from those advanced in books, especially from Dr. Falconer's views. He maintained that his hypothesis accounted for the facts mentioned by Mr. Dawkins, whilst Mr. Dawkins's hypothesis did not account for the facts adduced in the paper. The specimen brought by Mr. Gunn was decidedly not from the Suffolk bone-bed, but from overlying beds.

2. "Notes on an Ancient Boulder-clay of Natal." By Dr. Sutherland, Surveyor-General of the Colony. Communicated by Prof. Ramsay, F.R.S., F.G.S.

The author described the extensive occurrence in Natal of a formation which he considered to present the essential characters of Mr. Bain's "claystone porphyry." It consisted of a greyish-blue argillaceous matrix, containing fragments of Granite, Gneiss, Greenstone, Clayslate, etc., often of large size, exhibited ripple-markings in some places, and in others showed a rude approach to wavy stratification. It rested generally upon old Silurian sandstones, the upper surface of which was often deeply grooved and striated. The author regarded this deposit as an ancient Boulder-clay, perhaps of Permian age.

Discussion.—Dr. Mann called attention to some specimens which he had brought in illustration of Dr. Sutherland's paper, which showed the gradual transition from a state closely resembling that of an igneous rock into that of a truly stratified deposit.

Mr. T. M'K. Hughes, while admitting a recurrence of glacial periods, disputed the evidence in the cases hitherto brought forward. He adduced instances of the accumulation of similar fragments in ancient and recent deposits, which could not be referred to glacial origin; and showed how striation of the included fragments was frequently produced by movements in the mass subsequent to consolidation, pointing out that the supposed glacial deposits of Old Red age were formed under conditions similar to those under which such irregular accumulations were formed at the present day; that all the striated fragments occurred close to faults; that the Permian in the north of England, where it was deposited between high mountains, and might, therefore, be expected to be supplied in part by glaciers, contained no fragments from the higher ground of the Pennine range. He urged that the Natal deposit was not like a boulder clay, being rippled-marked and distinctly bedded, and that it had been subjected to pressure so great as to have produced distinct cleavage.

Prof. Ramsay combated the views of Mr. Hughes, and maintained that there was no necessity for supposing that all the pre-Carboniferous rocks were above water at the time of the deposit of the Permian beds of the north of England. Still he had never maintained that any of these deposits were due to glacial action, but only more southern beds. He pointed out that in the Natal beds under discussion, enormous blocks of rock occurred, which were sixty or eighty miles from their original home, and still remained angular; and there was a difficulty in accounting for the phenomena on any other hypothesis than that suggested. He still maintained the probability of the occurrence of glacial episodes, not only in Permian but in other ages, as he had done now fifteen years ago. A boulder-clay might be recognized, not only by the striæ on the stones, which were not always present, but by their shape and the general character of the agglomeration of the beds.

3. "On the Distribution of Wastdale Crag Blocks, or 'Shapfell Granite Boulders,' in Westmoreland." By Prof. Robert Harkness, F.R.S., F.G.S.

The author described the position of Wastdale Crag and the general distribution of the blocks of granite derived from it, and discussed the hypotheses which have been proposed to account for this distribution, and especially to explain how the blocks could have been transported to the eastern side of the elevated ground of Stainmoor. The author considered that neither of the extant hypotheses, accounting for the transport of these blocks by the agency of a glacier or of icebergs, was tenable; and he indicated what he regarded as the chief objections to each of them. He suggested that their transport had been effected by the agency of coast-ice, the land being depressed to the extent of about 1,500 feet, which would leave the Wastdale *Crag* sufficiently exposed to atmospheric action to enable it to furnish the blocks; the icefloes serving as rafts, would suffice to convey the blocks to other parts of the coast, whilst they would not require any great depth of water to float them.

Discussion.—Mr. Hughes pointed out some difficulties in accepting the theory of the transport of these blocks by means of coast-ice, but was not able to offer any better solution of the question than that suggested by the author.

CORRESPONDENCE.

THE BOULDER-CLAY OF CAITHNESS.

Sir,—In the first part of his paper on this subject, Mr. Croll says, "The notion that unstratified Boulder-clay could be formed by deposits from floating ice is not only erroneous but is also positively pernicious."

The great chalky boulder-clay or uppermost of the glacial deposits of East Anglia, though of great thickness, is everywhere destitute of stratification, and, according to Mr. Croll's dictum, no part of it can have been deposited from floating ice. This clay, however, rests over large districts upon a thick sand and gravel formation; and it may be seen in coast sections some miles in length thus to rest continuously, the sands below it being finely stratified and of undisputed marine origin. The junction of this unstratified clay with the sands is there quite undisturbed, presenting an even line of transition; while in other sections a passage-bed, a few feet in thickness, formed of the sand and clay interstratified, not unfrequently marks the junction.

Now, had a mass of ice pushed over this sandy sea bottom, and so produced the unstratified boulder-clay thus covering it, or had that clay itself been pushed over the sands, these could not have escaped being squeezed up and contorted, instead of having, as is the case, their stratification undisturbed up to the very line of junction. Instances, moreover, occur where this unstratified clay makes a dip into the previous sandy sea-bottom; and where a cross section of such a dip can be obtained, the sands are found undisturbed, except in the space ploughed, a feature obviously pointing to the impact of a floating body upon the sea-bottom. In rare instances, threads of sand a few inches thick occur in this unstratified clay; and if there chance to be two such threads together, their horizontality to each other is preserved. Conversely to this, I may add, that a band of this unstratified clay, two or three feet thick, but in all respects undistinguishable from the mass of the boulder-clay itself, is to be found in some instances interbedded in the sands and gravels to which I have just alluded, the stratification of these, both above and below such band, being quite undisturbed.

I dissent from so many of Mr. Croll's views that I would not have troubled you with this letter upon only one of them, but that I am unwilling so unqualified and denunciatory a statement should remain longer without a traverse.

Brentwood, Essex. Searles V. Wood, Jun.

LITHODOMOUS PERFORATIONS.

SIR,—The subject of "Lithodomous perforations" in limestone rocks above the present level of the sea, has for some time occupied so large a space in the GEOLOGICAL MAGAZINE as to furnish me with an excuse for troubling you with the following passage from the "Natural History of South Devon," by J. C. Bellamy, Surgeon, 1839, pp. 114-5:—"The usual height of the ancient beach in Plymouth Hoe (now nearly destroyed) is about 30 feet above present high-water mark. The rock on which it rests is often smoothened, and specimens of *Pholas dactylus* are found in it; and the roundness of the pebbles, and the existence of these shells in the smoothened rock, sufficiently show that the sea rested there awhile." I will only add that Mr. Bellamy resided in the neighbourhood, and was one of the curators of the Devon and Cornwall Natural History Society.—I am, etc.,

TORQUAY, *June* 13, 1870. WM. PENGELLY.

FOSSIL INSECTS.

SIR,—In the March number of the GEOL. MAG. (p. 141), a correspondent refers to the Tertiary Insect-remains of Dorset. I am thereby reminded that Mr. W. R. Brodie informed me some years since that two of the fossil insects described in Mr. Westwood's elaborate memoir in the *Quart. Jour. Geol. Soc.* vol. x., pages 378–96, were, by inadvertence, wrongly located, namely,—Plate XIV. Fig. 4, Doubtful elytron, is Tertiary, from Creech near Wareham, Dorset, (not from the Lower Purbeck). Plate XIV. Fig. 8, Wing of Giant Ant (not from the Lower Purbeck).

ROYAL MILITARY COLLEGE, SANDHURST,
10*th June*, 1870.
T. RUPERT JONES.

MISCELLANEOUS.

◆

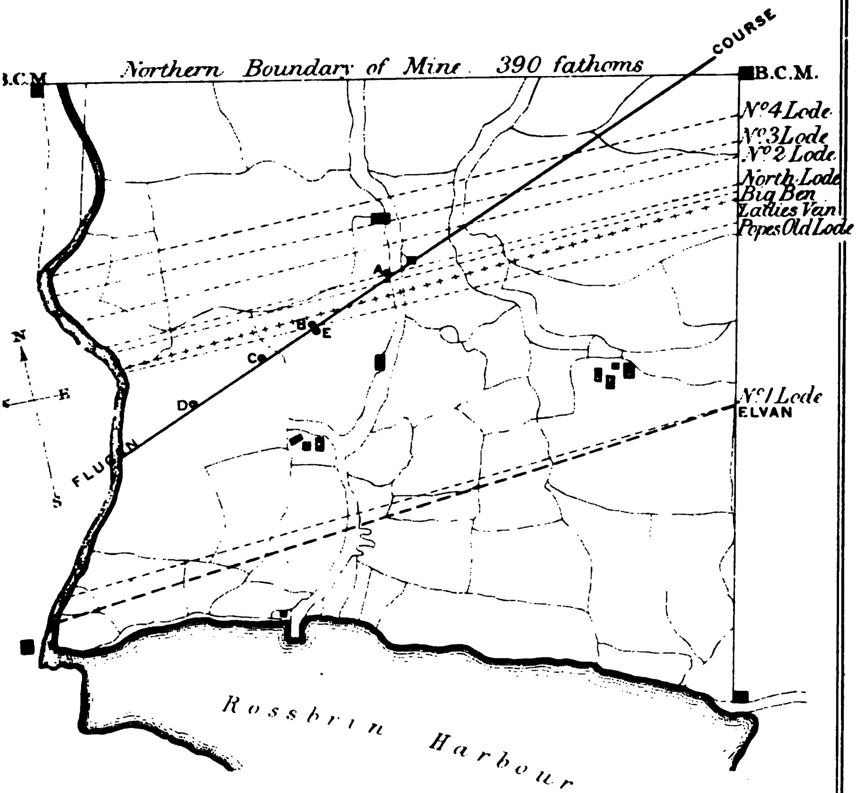
DIAMONDS IN BOHEMIA.—Dr. A. Fritsch informs us that a Diamond has been found in Bohemia. The locality is on the southern part of the basaltic mountains, on the fields near Dlaschkovic, between Podsedic and Chrăstăn, on the road from Zobosic to Laun. Before its examination this very hard stone was believed to be a Zircon, but the careful investigation of M. Schafarik, Professor of Chemistry, at Prague, has shown it to be a genuine diamond. The weight is 67 millimètres, colour yellowish, largeness 4 millimètres long, 2½ millimètres broad, density 3·53. Indications of octahedral planes are to be seen. A fragment was burnt in oxygen, and entirely disappeared; this experiment was performed in the presence of numerous reliable witnesses. The specimen has been presented by Count Ervine Schïnborn to the Museum of Prague.

We have received specimen-plates of a new work, now in preparation by M. M. Fritsch and Schloenbach, "On the CEPHALOPODA of the Chalk-formation of Bohemia," to contain about 14 quarto plates

It is much to be regretted that we cannot obtain Artists or Lithographic Printers able to compete, either in price or qualityof work, with those of France, Germany, or Austria.

PLAN OF BALLYCUMMISK MINE, CO. CORK.

SCALE – 1 INCH = 115¼ FATHOMS.



REFERENCE.

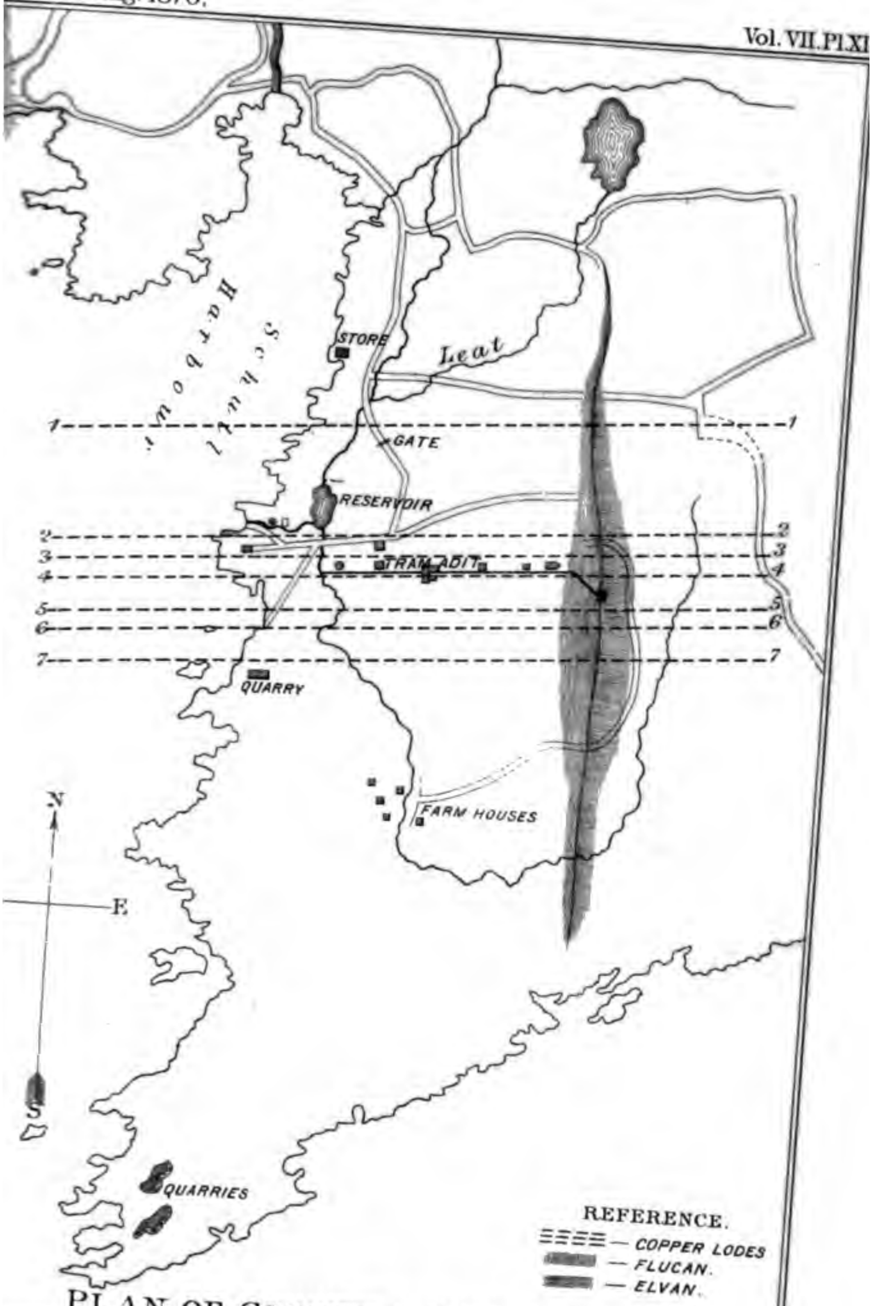
A . SKIP SHAFT.
B . WHIM ENGINE.
C . PUMPING ENGINE.
D . WEST SHAFT.
E . STAMPING ENGINE.

Vincent Brooks Day & Son

(To illustrate Mr Samuel Hyde's paper in the M

Geol. Mag. 1870.

Vol. VII. Pl. XI



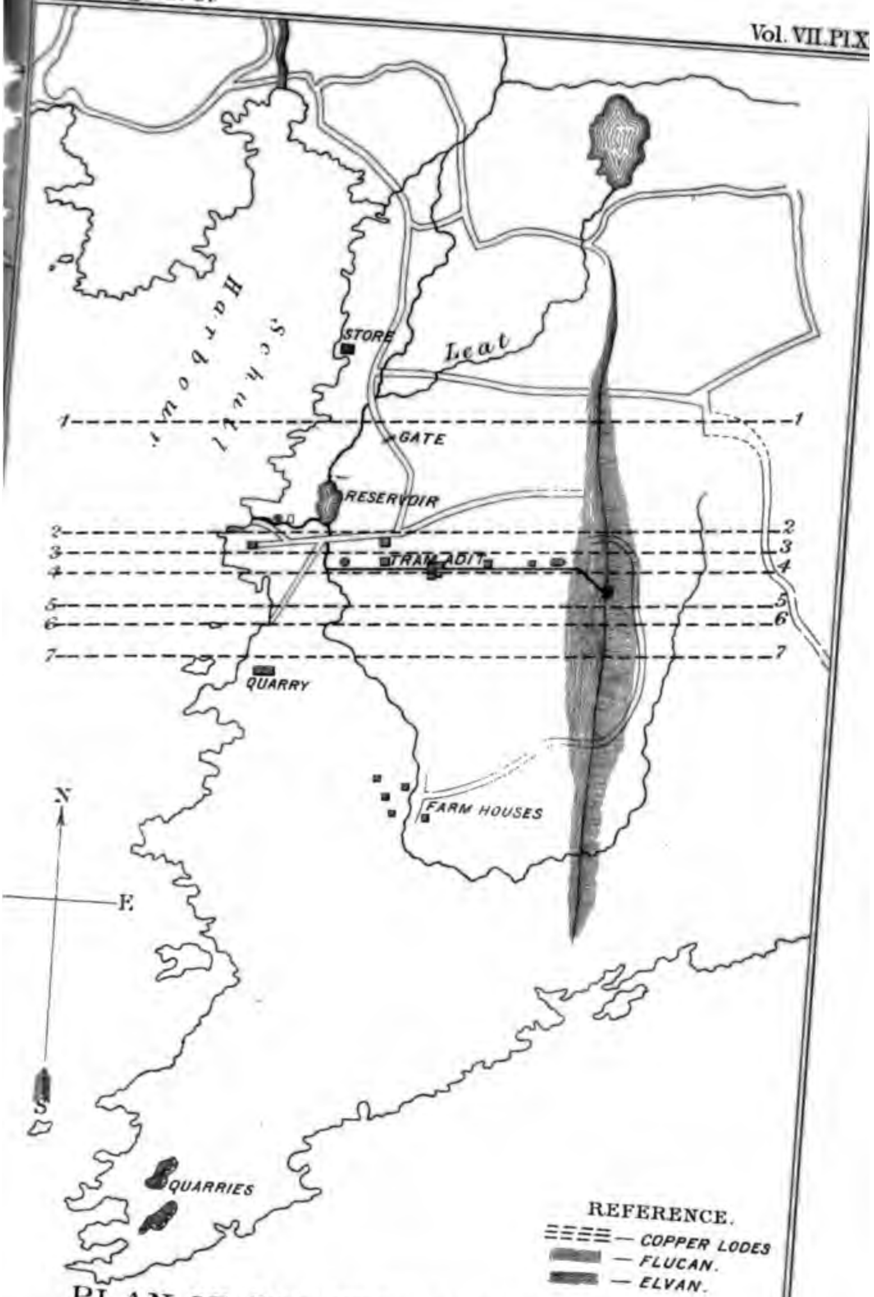
PLAN OF COOSHEEN MINE, CO. CORK.

Vincent Brooks Day & Son lith.

To illustrate Mr Samuel Hyde's paper in the May No

Geol. Mag. 1870.

Vol. VII. Pl. X



PLAN OF COOSHEEN MINE, CO. CORK.

Vincent Brooks Day & Son lith.

To illustrate Mr Samuel Hyde's paper in the May N

THE
GEOLOGICAL MAGAZINE.

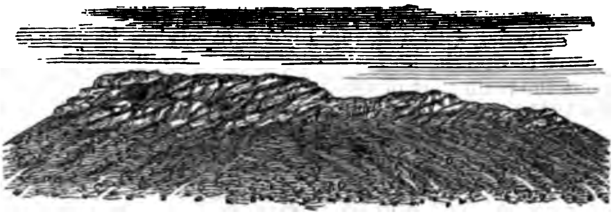
No. LXXIV.—AUGUST, 1870.

ORIGINAL ARTICLES.

I—ON THE DISPERSION OF SHAPFELL BOULDERS AND ORIGIN OF BOULDER-CLAY.

BY D. MACKINTOSH, F.G.S.

AS the attention of geologists has lately been re-directed to the above subjects by Mr. S. V. Wood[1] and Prof. Harkness,[2] I enture to hope that the following notes and observations, made uring visits to Wasdale Crag and the neighbourhood, on the 7th nd 15th of last June, will not prove uninteresting to the readers of e GEOLOGICAL MAGAZINE.



View of Wasdale Crag from the opposite side of Wasdale.

Boulders of granite from Wasdale Crag (or, as it may more coneniently be called, Wasdale Hill—the Crag being its southern scarpment) may be found down the valley of the Eden at a great istance from their parent rock; but it is not until one arrives at hap village, on his journey southwards, that the boulders begin to btrude themselves on his attention. A little beyond the Greyhound n, he will find that at least one-fourth of the stones which have een gathered off the fields are granite, many of the others being a ind of basaltic trap from the neighbourhood of Wasdale Hill. urther on he cannot fail to be struck with the number of huge ranite boulders in the roadside walls, some of them angular, but any of them considerably rounded. I have been informed that ere are few or no granite boulders much further west than Shap bbey; and in this neighbourhood, therefore, the current which transported the boulders in a northerly direction must have had its western boundary.

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[1] Quart. Journ. Geol. Soc., Vol. xxvi. p. 90, paper read Dec. 8, 1869.

[2] I was not present at the reading of Prof. Harkness's paper on the 25th of last ay, but from the few lines of abstract in the fortnightly notices of the Geol. Soc., it ould appear that, so far as the dispersing action of coast ice is concerned, his views gree with those advocated in this article.

About a mile south of Shap, 5 or 6 feet in thickness of grey or greyish-brown "pinel," nearly as hard as rock, may be seen lying on Carboniferous limestone. It is rudely laminated, and contains many stones and boulders, including a large per-centage of Wasdale Hill granite. It is covered with a thin bed of red or foxy-coloured loam and loamy clay, with comparatively few stones. This was the first though not the most convincing indication I saw of what I expected, namely, that the Wasdale Hill boulders are "a part and parcel" of the pinel or mountain boulder-clay (for it is not to be found far away from the mountains) of the Lake District. Further on, I saw a block of granite on the roadside, about 12 feet in average diameter, and Mr. Hetherington, of the Shap Granite Company, informed me that he had seen a block high up on the side of a neighbouring hill, which measured 20 × 15 × 5 feet. He likewise mentioned that he had seen a large block horizontally fractured, as if it had violently struck against another block or the rocky bottom of the sea. I afterwards saw several split blocks.

Near the Polishing Works, Shap Summit, a yellowish-brown pinel, so hard that it might appropriately be called Post-tertiary conglomerate, makes its appearance on the roadside. Here (as elsewhere) it is often covered with a facing of the overlying loose loam, and might easily escape the notice of one not in search of it, although it constitutes the main part of the drift of the district.

At the Polishing Works my attention was directed to the fact, that on some of the higher eminences to the north-east there are many granite boulders on the slopes facing Wasdale Hill, but none on their tops. Should it be found that on none of the eminences to the north and north-east of Wasdale Hill are there any boulders at a greater height than 900 or 1,000 feet above the sea, it would favour the supposition that at the time when the boulders were floated in these directions the land had not been so deeply submerged as when the transportation over Stainmore Pass occurred. At the latter period, the land must have been submerged to a greater depth than 1,400 feet, and during an intermediate submergence of about 1,300 feet the boulders may have found their way, nearly in the direction of the Shap and Kenda Road, into the valley of the Kent. The courses of the ice- and boulder-laden currents may have changed as the land became more deeply submerged. That the boulders did not find their way over lower gaps in the Pennine chain to the south of Stainmore can, I think, be easily explained, on the supposition that currents embracing Wasdale Hill or its neighbourhood, in their course, did not happen to flow through these gaps. There are many directions besides those in which these gaps are situated, which would appear to have never been traversed by currents laden with Shap granite boulders.[1]

On walking along the tramway-cutting from Shap summit to the granite quarry, great boulders are found, not only on the surface, but completely buried in the pinel, which is here both grey and yellow, and rudely laminated—the laminæ being generally inclined or arched. It often graduates into a well-rounded conglomeratic gravel. The boulders here are chiefly whinstone (local basaltic trap) and granite. The nearer one gets to the quarry, the more one sees that the dispersion of the boulders and the accumulation of the pinel were contemporaneous.[1] On the slopes of Wasdale Hill, the pinel with granite boulders runs up to the bases of the rocky ledges, and fills up hollows. It differs but little from what one might regard as a beach deposit on a *steep* shore, where the stones would roll down or be washed down, and become imbedded in clay beneath the level of the assorting action of waves. At the same time, ground-ice and coast-ice must have had a share in giving rise to the peculiar character of this remarkable deposit.[2]

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[1] According to Mr. Green, of the Geol. Survey, there is a Shap granite boulder in the village of Royston, near Barnsley, and according to the Rev. J. Stanley Tute,

The south side of Wasdale Hill, down to a level of about 1,100 feet above the sea, is craggy, and the rocks are more or less moutonnéd. On the sloping face of the hard and compact rocky escarpment there are very few loose boulders, and still fewer on the summit. On the eastern side of the hill numbers may here and there be seen, but, excepting towards the base of the hill, surface-boulders are nowhere very plentiful. In cutting the tramway, however, thousands of them were dug out of the pinel.

At the quarry, near the western end of the Crag, blocks as large as 40 × 30 × 15 feet are sometimes obtained by blasting. The granite is exceedingly hard, and little liable to be acted on by the weather. Here the pinel not only rises up to the base of the Crag, but runs up the sloping rock-surface until it terminates against the minor cliffs. In some places it adheres so tenaciously to the moutonnéd rock, that it is removed with great difficulty. The finer part of the deposit would appear to have come from the S.S.W.

Glaciated Granite.—I was fortunate in discovering a good-sized surface of granite which had been lately cleared of pinel, and it was nearly as exquisitely polished as at the Shap Summit Works. On throwing a bucketful of water on the surface, the grooves could be distinctly seen running nearly in the direction of E.N.E., or obliquely up the face of the sloping Crag. To the west of the quarry I afterwards found the glaciation running N.N.E. As the granite was not much planed down, but polished somewhat conformably to the undulating divisional planes, ice borne by a current from the direction of Wasdale Head may have glaciated the rock

there are some Shap granite boulders in the brown clay west of Ripon. Is it certain that they all came over Stainmore Pass?

[1] The number of large granite boulders on the surface of or rather slightly imbedded in the pinel and overlying loam, may have resulted from the continual dropping down of boulders from the floating ice, as the land became more and more deeply submerged, and after the accumulation of the pinel had, in a great measure, ceased.

[2] Apart from the evidence the pinel presents of the action of ice, it somewhat resembles the brecciated part of the raised beach of Weston-super-Mare, which would appear to have been accumulated on a steep slope, as the land was sinking, and it is not very dissimilar to portions of the Old Red Conglomerate at the foot of Ullswater.

uphill on grounding. It could not have been caused by the valley-ignoring agency which glaciated a great part of the Lake District from N. to S., while the physical geography of the district forbids the idea of a local glacier, from the W.S.W. or W.S., acting at a sufficient height to smooth and score the southern face of Wasdale Crag up to the summit, for on the summit the rocks are moutonnéd. A valley-glacier, moreover, could not have carried granite boulders from Wasdale Crag transversely over the adjacent valley, and left them in great numbers on the opposite or southern side. Much less could a valley-glacier, or any movement of land-ice, have dispersed the boulders in the many different directions in which they are found. It is true the glaciation of the rock-surfaces and the distribution of the boulders may have been separate events, but the preponderance of evidence here seems to be in favour of the idea that all the superficial phenomena partially originated while the land was submerged.

Mode in which the Boulders were launched.—There would appear to be little difficulty in conceiving how the boulders in the neighbourhood, at comparatively low levels, on the N., E., and S.E., may have been floated by coast-ice; for though the cliffs and rocky projections of Wasdale Hill are too sloping and the granite too hard to furnish many blocks and fragments by the force of gravitation combined with the dilapidating action of frost, all must admit that the sea is pre-eminently a block-detaching agent.[1] The process of natural quarrying carried on by the waves at successive levels, as the land subsided or rose, would have supplied an immense number of blocks, and, at the same time, rounded those of them which present indications of having been subjected to attrition. The small number of boulders remaining on the surface of the hill, or not imbedded in the pinel or overlying loam, would seem to show that the transportation must nearly have kept pace with the process of natural quarrying and rounding. The breaking-up of coast-ice, and ground-ice converted into coast-ice, would appear sufficient to explain the launching of the boulders from what must have been a steeply-sloping sea-beach, progressively advancing down and up the sides of the hill as the land sunk or rose. But it is probable there were pauses in the oscillation of the land. Some of these may be represented by the great terrace of boulder-pinel and red loam at the base of the hill in the direction of Shap Wells, and by the terraces at higher levels on the N.N.E. side of the hill. The myriads of boulders transported over the 1,400-feet level of Stainmore Pass would seem to indicate another pause when (taking into account the depth of water required to float ice) very little, if any, of Wasdale Hill appeared above the sea, that is, supposing Stainmore Pass and Wasdale Hill to have been afterwards equally upheaved.

Derivation of the Great Eastern Dispersion.—How could a few feet of land, a few hundred yards in diameter, above low-water level, have supplied all the Wasdale Hill granite to be found to the east of

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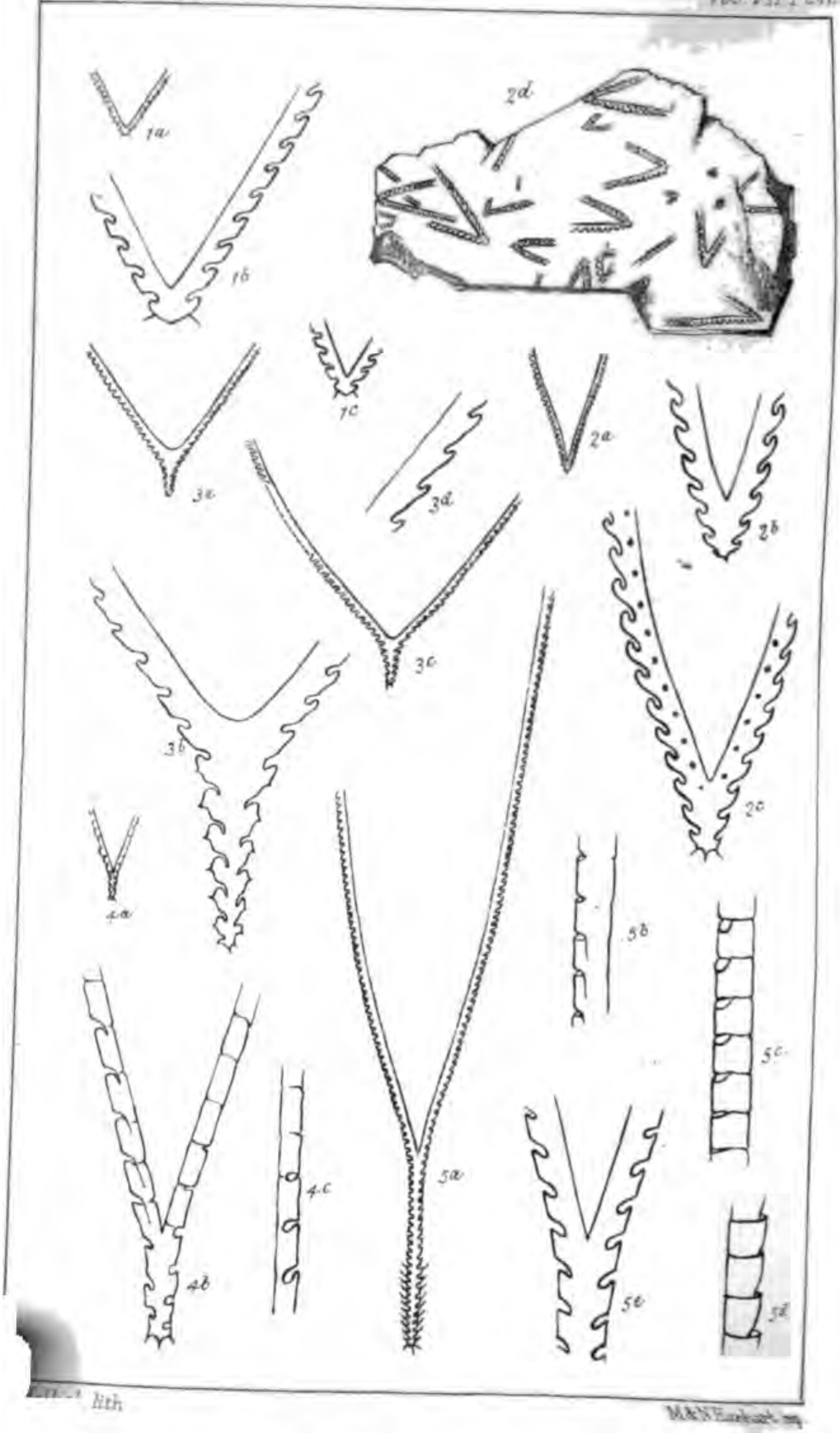
[1] See Mr. E. Hull's able article "On the Raised Beach of Cantyre," on block-detaching agency of the sea.—GEOL. MAG., 1866, Vol. III. p. 7.

Geol. Mag. 1870. Vol. VII Pl. XVI.



[illegible] lith

M & N Hanhart imp.

BRITISH SPECIES OF THE GENUS DICRANOGRAPT the Pennine range of hills? The progressively upward action of ground-ice during storms may partly furnish an answer to this question, but I think the main explanation must be sought for in the denuding action of sea-waves encroaching on the top of the hill, which at one time may have been higher than at present. A previously-existing conical eminence may have been *truncated* by the sea, so as to leave the "plain of marine denudation," or table-land, now forming the summit of Wasdale Hill; and it is possible, if not probable, that the hill may have lost several hundred feet of its height during the process of natural quarrying which supplied the floating ice with all the boulders which found their way across Stainmore Pass. The preponderance of Wasdale Hill granite among the larger transported boulders (at least in many areas) may be accounted for by the fact that the compactness and distance between the joints or fractures of the granite would cause it to break up into blocks much larger than those resulting from the dilapidation of the neighbouring rocks, many of which indeed, would break up into mere chips or splinters.

Concluding Remarks.—The foregoing facts and considerations lead us to the conclusion that the cause which dispersed the boulders from Wasdale Hill *radiated* from the hill as from a centre. But the insignificant summit of the hill could not have supported a nearly sufficient quantity of land-ice to have furnished the floating ice on its breaking-up, while land-ice in such a position could not have detached the blocks from the solid rock. The blocks therefore must have been detached and rounded by sea-waves and sea-ice, and floated and transported by the latter. Winds may have partly or chiefly propelled the ice which floated the boulders found in the neighbourhood of Wasdale Hill, but currents must chiefly have carried the ice with the boulders which are found at great distances. Though the finer part of the pinel and loam must in a great measure have been derived from a source different from that which supplied the granite boulders, the accumulation of the pinel and loam and imbedding of the boulders must have taken place contemporaneously while the land was submerged.

The causes of the glaciation and mode of accumulation of the Drifts of other parts of the Lake District will form the subject of a future article.

II.—ON THE STRUCTURE AND AFFINITIES OF THE GENUS *DICRANOGRAPTUS*.

By JOHN HOPKINSON, F.G.S., F.R.M.S.

(PLATE XVI.)

THE name *Dicranograptus* was proposed by Hall, in his Memoir on the "Graptolites of the Quebec Group" (p. 112), for certain forms of Graptolites, some of which were then included in the genus *Didymograpsus*, and others in *Diplograpsus*. He, however, only considered these forms as constituting a sub-generic group of his genus *Climacograptus*, believing them to have a similar structure.

Mr. Carruthers then described this group as a distinct genus, restricting it to the typical species *D. ramosus*, and its allies; and at the same time, from an examination of British specimens, he dissented from Hall's conclusion as to its structure, which he considered to be exactly similar, in its proximal portion, to *Diplograpsus*.[1]

I have already expressed the opinion that "in *D. ramosus*, the hydrothecæ appear to have the same structure as in *Climacograptus*,"[2] and I now intend to show, that, so far as can be judged from the imperfect state of preservation in which our British specimens are found, not only this species, but the entire genus, although frequently somewhat similar in the form of its hydrothecæ to *Diplograpsus*, is, nevertheless, more nearly allied to *Climacograptus*.

The genus may be thus briefly described:—

Genus *Dicranograptus*, Hall. Grapt. Queb. Gr. p. 112. (from *δίκρāνος*, two-headed; *γράφω*, I write.)

Polypary with a double series of hydrothecæ on the proximal portion or stem, which divides distally into two branches, bearing hydrothecæ, continuous with those on the stem, on their outer aspect only.

The proximal portion is composed of two distinct series of hydrothecæ, each having its own common canal, as shown by their protecting periderms separating from each other in the axil of the branches.[3] From this point, the branches, bearing hydrothecæ on their outer aspect only, diverge symmetrically, forming various angles with each other. The solid axis, commencing in a minute radicle,)which is flanked by two lateral spines, processes from the first-formed thecæ,) runs up the centre of the polypary, between its coalescing dorsal walls (?), and, being double, bifurcates in the axil of the branches, becoming thus dorsal to each branch. The hydrothecæ are usually undistinguishable from each other for some portion of their length; we cannot trace the division between any two adjoining hydrothecæ towards their proximal end, nor can we say where the periderm and its thecæ are connected: but sometimes a line of separation can be traced, the distal margin of one theca having parted from the proximal margin of the next. The apertures extend right across the distal end of each hydrotheca, from its apex to its junction with the next succeeding theca. They are apparently situated in a hollow, or incision, in the body of the polypary, and are therefore not exposed beyond the general margin of the polypary.

It is evident that we can only compare the proximal, or diprionidian portion of the polypary with the genera *Diplograpsus* and *Climacograptus*, as they have a double series of hydrothecæ throughout their length. But let us first see in what *they* differ from each other. Hall gives sections of *Climacograptus typicalis*[4] which show,—first, that in this species the solid axis is a slender cylindrical rod or tube, passing through the centre of a canal which is common to the two series of hydrothecæ,—and secondly, that the hydrothecæ, where they are in contact, are formed simply by excavations in the body of the polypary. Dr. Nicholson, on the other hand, states that in *Climacograptus scalaris* the two series of hydrothecæ are not organically connected with each other, their dorsal walls "coalescing to form the median septum, along the centre of which runs the solid axis."[1] This is precisely the structure of *Diplograpsus.* We have also numerous figures, evidently accurate, of *C. scalaris,*—I refer more especially to Scharenberg's,[2]—which show that the hydrothecæ, where usually in contact, are occasionally separated by a slight interval, proving that they are really distinct from the body of the polypary, and not simply formed by excavations in its sides. This, also, is the structure of *Diplograpsus.* In what then do they differ? In *Climacograptus,* as also in *Dicranograptus,* the separation of the hydrothecæ is only occasionally seen, and very seldom extends to the common periderm. In *Diplograpsus* it is invariable; the hydrothecæ, though adjoining each other for some portion of their length, are entirely distinct and complete in themselves to their junction with the periderm.

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[1] GEOLOGICAL MAGAZINE, Vol. V., p. 132.

[2] Journ. Quekett Micros. Club, vol. i., p. 160.

[3] That the two series of hydrothecæ are really thus isolated, I am by no means certain. Pending further investigation, I quote the view generally entertained.

[4] *Grapt. Quebec Group*, pl. A., fig. 4–8.

The two genera also differ in the position of the apertures of their hydrothecæ. In *Diplograpsus* they are situated at the apex of the free end of each theca, while in *Climacograptus* they are situated in a hollow which appears to be excavated out of the polypary. In *Dicranograptus* they are situated in an exactly similar manner, the outer margin of each hydrotheca being brought over the aperture of the one which precedes it.

It is thus seen that in the isolation of the two series of hydrothecæ the three genera do not differ, while *Dicranograptus* and *Climacograptus* alone are alike in the usual intimate connection, and only occasional separation, of the hydrothecæ near their origin, and in the position of their apertures. *Dicranograptus,* however, differs from *Climacograptus* in its hydrothecæ being usually, but by no means always, more prolonged distally, in which respect alone it more nearly approaches *Diplograpsus*; but it is evident that this is only a slight variation in form, attended by no corresponding change in structure. We may therefore conclude that the genus is most nearly allied to *Climacograptus,* essentially differing from it in the dividing of its polypary (its generic character) alone.

It is also nearly allied to a section of the genus *Didymograpsus,* which I intend to describe on a future occasion.

The genus *Dicranograptus* is exclusively Lower Silurian. It first appears, represented by a single species only, *D. ramosus,* in the Arenig of North Wales, and is then seen in the Llandeilo of Wales, and of the south and south-west of Scotland, where it attains its maximum, both in the number of species and of individuals, From one locality, Moffat, Dumfriesshire, five species have been obtained —all that are known to occur in Britain. One species, *D. sextans,* then appears in Ireland. In the Hudson River Group of Canada and New York, two British species, *D. ramosus* and *D. sextans*, are found, associated with another species, *D. furcatus* (Hall), not known to occur in Britain. *D. ramosus* also extends to the Lower Silurians of Australia, thus having a very great geographical range.

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[1] Quart. Journ. Geol. Soc., vol. xxiv., p. 528.

[2] Ueber Grapt., pl. ii., fig. 17–22.

The genus is represented in Britain by the following species:—

1. *Dicranograptus sextans*, Hall (1865), Grapt. Queb. Group, p. 57. *Graptolithus sextans*, Hall (1847), Pal. New York, vol. i., p. 273, pl. lxxiv., fig. 3. *Diplograpsus* (*?Didymograpsus*) *sextans*, McCoy (1851), Pal. Foss., p. 9.—Pl. XVI., Fig. 1.

Polypary with an extremely short diprionidian stem, dividing into two short and slender monoprionidian branches, which diverge from each other at an angle of about 60 degrees. Hydrothecæ from 30 to 35 to the inch; free for fully half the width of the polypary; curvilinear in outline, but with an outer margin nearly straight towards the distal end. Apertures situated on the convex distal margin of each hydrotheca, and forming an angle of about 45 degrees with the axis.

The first two hydrothecæ only are united, forming an undivided portion which can scarcely be called a stem, for it is not more than 1-30th of an inch long, exclusive of the minute radicle and slender lateral spines. The branches are from one-third to nearly half an inch long, and about 1-30th broad, and are remarkable for the constancy of their angle of divergence, which is the same in both American and British specimens. The hydrothecæ are decidedly curved in their free portion, and in British specimens have no mucronate point, as described and figured by Hall. They are nearly parallel with the axis in their outer margin, are slightly rounded off to the aperture, and prolonged until forming an angle of from about 30 to 40 degrees with the axis.

The position of this species is somewhat doubtful, but it seems nearer to *Dicranograptus* than to the allied species of *Didymograpsus*, with which it is usually associated. The stem is certainly exceedingly short—almost rudimentary; but it bears a fair proportion to the entire polypary, being nearly 1-10th the length of the branches; and there is no indication of a spine opposite the true radicle, as in the most nearly allied species of *Didymograpsus*, which, moreover, have very long branches.

Loc. *Arenig*:—Braithwaite Brow, Skiddaw, Cumberland (Salter)? *Llandeilo*:—Builth, Wales; Glenkiln Burn, Dumfriesshire; Loch Ryan, Wigtownshire; Kilmacreagh, etc., Clare, Ireland (Baily). *Caradoc*:—Canada and New York (Hudson River Group).

2. *Dicranograptus formosus*, sp. nov.—Pl. XVI., Fig. 2.

Polypary with a very short diprionidian stem, dividing into two slender monoprionidian branches, which diverge from each other at an angle of from about 30 to 45 degrees. Hydrothecæ from 30 to 35 to the inch; free for a third, or sometimes nearly half the width of the polypary; curvilinear in outline, and more or less incurved towards the distal end. Apertures situated on the convex distal margin of each hydrotheca, and forming but a slight angle with the axis.

The branches are only conjoined at the proximal end for the space of two and a half or three hydrothecæ, forming a stem scarcely 1-10th of an inch in length. Commencing in a minute radicle, flanked by two delicate setiform spines, which are but rarely preserved, it widens out to the axil, and separates into two branches from 1-30th to nearly 1-20th of an inch wide, and, in the specimens examined, scarcely three-quarters of an inch long. They are nearly straight, and in well preserved specimens are ornamented by minute circular pustules or scars, which appear to mark the junction of the hydrothecæ and periderm. The hydrothecæ commence in their free portion with a concave outline, soon becoming convex. They are rounded off at the end, and are sometimes so much incurved that their apertures face directly inwards.

The branches are frequently twisted until the apertures of the hydrothecæ appear on their upper surface, and in this condition very much resemble "scalariform impressions" of *Climacograptus bicornis.*

D. formosus differs from *D. sextans,* to which it is most nearly allied, in the greater length of its stem, in the smaller angle of divergence of its branches, which are also longer and more robust, and in the elegantly curved form of its hydrothecæ. It has a slight resemblance to *Didymograpsus anceps* (Nich.), but may easily be distinguished from it by its possession of an undivided proximal portion, by the greater tenuity of its branches, and by the greater number of hydrothecæ in the inch.

Loc. *Llandeilo*:—Beld Craig Burn, Moffat, Dumfriesshire. (In black fissile shale.) Llanerchymedd, Anglesea, North Wales (?).

3. *Dicranograptus Nicholsoni,* sp. nov.—Pl. XVI., Fig. 3.

Polypary with a short diprionidian stem, much wider near the axil than at the proximal end, and dividing into two monoprionidian branches which diverge from each other at an angle of 70 or 80 degrees, and form with each other, at their origin, a continuous curve. Hydrothecæ from 20 to 25 to the inch, free for nearly half the width of the polypary; curvilinear in outline, but not incurved towards the distal end. Apertures extending around the convex distal margin of each hydrotheca.

The stem is about a quarter of an inch long, and has a minute radicle and two equally minute lateral spines, which are seldom seen. The branches are from 1-30th to 1-20th of an inch wide, and attain a length of at least an inch and a half. They are joined together at about a tenth of an inch beyond the point of bifurcation of the axis. This, which is a constant and very peculiar feature, may be analogous to the conjoining of the branches of *Didymograpsus Moffatensis* (Carr.) "by a slight web," or even to the central disc of *Dichograpsus*; but it seems to differ from both in the conjoining portion being continuous with, and undistinguishable from, the general body of the polypary. The hydrothecæ are smaller and closer together in the stem than in the branches, and very nearly approach each other towards their outer margin, which, in the stem, has an obtuse mucronate extension or spine, directed outwards, or at right angles to the axis, and in the branches, a slight depression. In general form its hydrothecæ mostly resemble those of *D. sextans*.

D. Nicholsoni is nearly allied to *D. ramosus*, but may be readily distinguished from it by the shortness of its stem, the greater divergence of its branches, and the curved form of its axil. I have named it after Dr. H. A. Nicholson, who, by his researches in the Skiddaw Slates and Coniston Flags, has added so much to our knowledge of the British Graptolites.

Loc. *Llandeilo*:—Dobb's Linn, Moffat, Dumfriesshire. (In black carbonaceous shale.)

4. *Dicranograptus Clingani*, Carr. (1868), GEOLOGICAL MAGAZINE, Vol. V., p. 132, pl. v., fig. 6.—Pl. XVI., Fig. 4.

Polypary with a short, nearly parallel, diprionidian stem, dividing acutely into two very short monoprionidian branches, which diverge from each other at an angle of about 40 degrees. Hydrothecæ from 20 to 25 to the inch, free for nearly two-thirds the width of the polypary; angular in outline, or but slightly curved; and closely approximating each other towards their outer margin. Apertures at right angles, or nearly so, to the axis.

The stem, with its slender radicle and lateral spines, seldom reaches a quarter of an inch in length, and the branches, which are about 1-30th of an inch broad, do not exceed half an inch in length. The hydrothecæ are somewhat similar in form to those of *D. ramosus*, but much more frequently appear as "scalariform impressions." They seem almost entirely free, and are much elongated, and therefore very close together, much closer than in *D. ramosus*, from which this species also differs in its short stem, and short and slender branches, which never exceed the dimensions I have given. In the specimen illustrated, one branch is seen but very slightly distorted, while the other is so much altered by compression that the apertures of the hydrothecæ cannot be seen, the proximal end of each theca being shoved over the distal end of the one which precedes it.

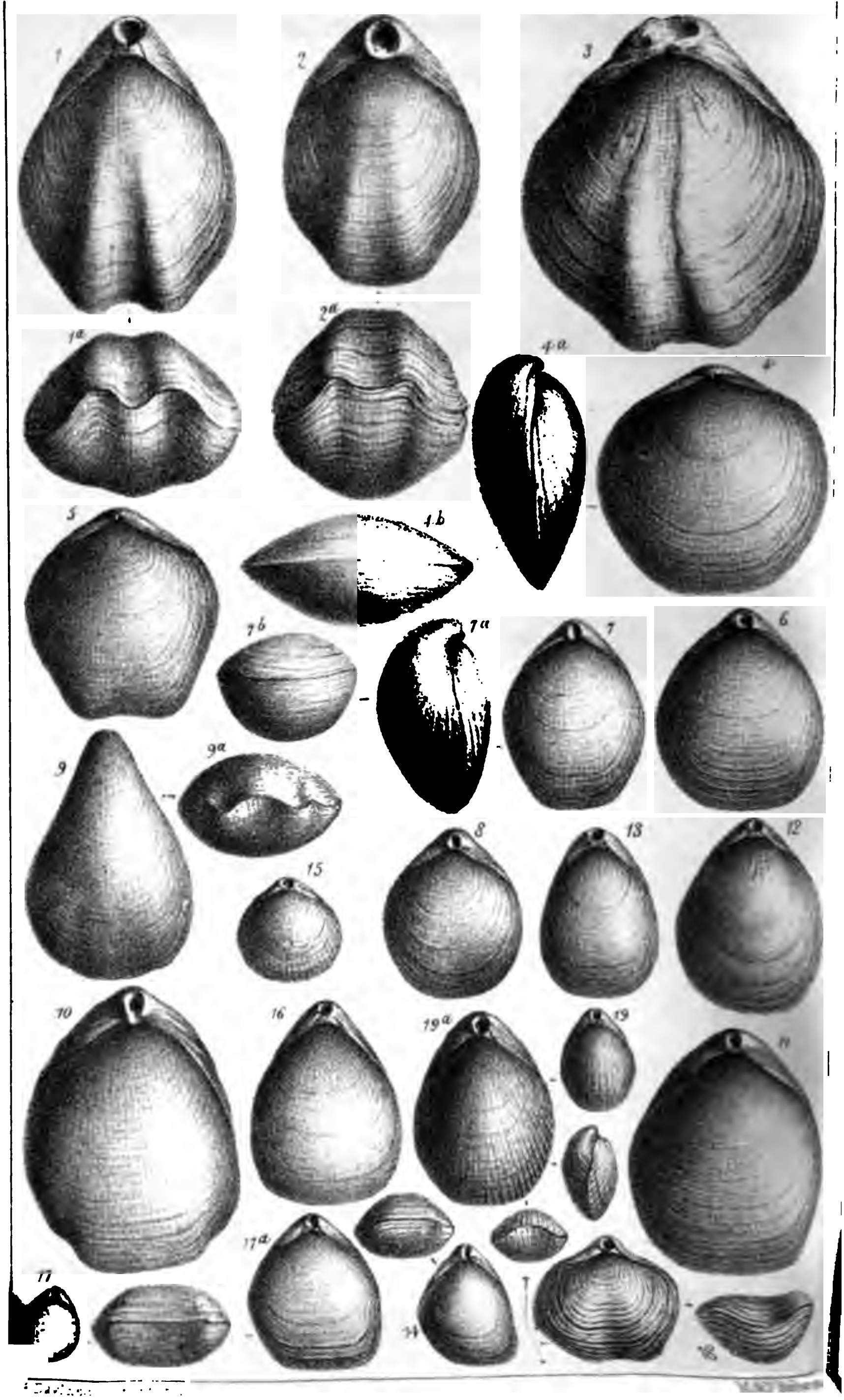
Loc. *Llandeilo*:—Dobb's Linn, Moffat, Dumfriesshire.

5. *Dicranograptus ramosus*, Hall (1865), Grapt. Queb. Group, p. 57. *Graptolithus ramosus*, Hall (1847), Pal. New York, vol. i., p. 270, pl. lxxiii., fig. 3. *Diplograpsus ramosus*, McCoy (1851), Pal. Foss., p. 8.—Pl. XVI., Fig. 5. *Cladograpsus inequalis*, Emmons (1855), Amer. Geol., vol i. p. 107, pl. i, fig. 12. *C. dissimilaris*, ib., fig. 15.—Pl. XVI., Fig. 5.

Polypary with a diprionidian stem of considerable length, wider towards the centre than at either end, and dividing acutely into two monoprionidian branches, which diverge from each other at an angle of from 20 to nearly 50 degrees. Hydrothecæ about 25 to the inch; free for half the width of the polypary; angular or subangular in outline; and separated from each other towards their outer margin by a considerable interval. Apertures forming an angle of about 45 degrees with the axis.

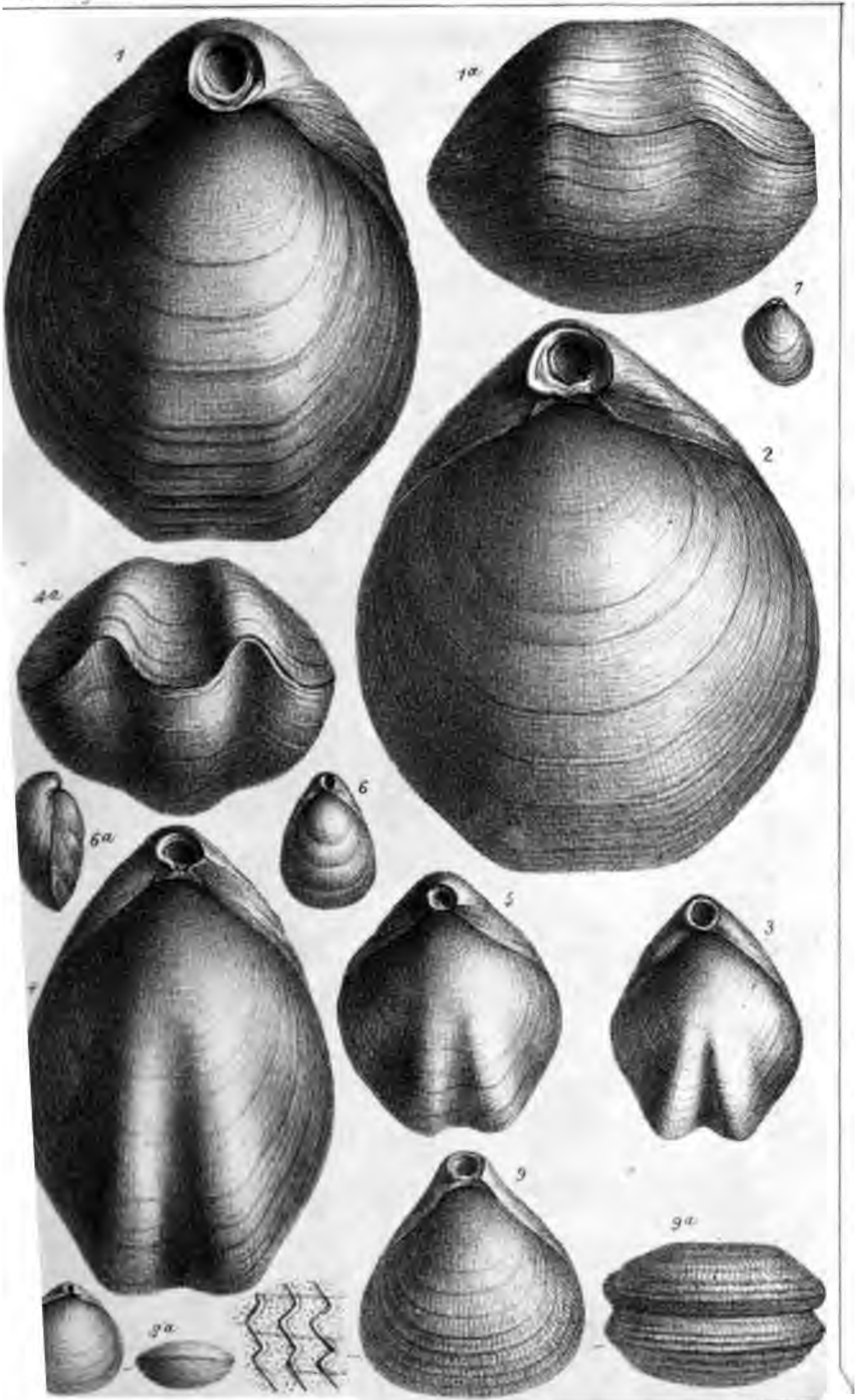
The stem is, as usual, furnished with a slender radicle and spines. It varies from half an inch to one inch in length, and sometimes attains a breadth of 1-8th of an inch at its widest part. The branches

Geol. Mag. 1870 Vol. VII Pl. X



Davidson

BRACHIOPODA



avias del. et lith. [illegible] Hanhart imp.

ITALIAN TERTIARY BRACHIOPODA.

vary from 1-20th to nearly 1-12th of an inch in breadth, and frequently attain a length of several inches. The hydrothecæ have a straight, or but slightly convex outer margin, which is parallel with the general outline of the polypary; and are produced distally, until forming an angle of about 45 degrees with the axis. In well preserved specimens a few of the hydrothecæ near the proximal end of the polypary have a slender acutely pointed spine proceeding from their outer margin, and directed more or less towards the distal end of the polypary; and in the branches, minute pustules, marking the junction of the hydrothecæ and periderm, are sometimes, though rarely, observed. The enlarged drawings of portions of the branches of this species are taken from the complete specimen figured, and present a variety of form difficult to comprehend. Indeed, I think it will be better to offer no explanation of the appearances here seen until better preserved specimens than any I am acquainted with can be examined. Emmons' species are evidently founded on imperfectly and unequally preserved specimens of *D. ramosus.*

Loc. *Arenig*:—Ty-obry, near Portmadoc, North Wales (Salter). *Llandeilo*:—Builth, and Abereidy Bay, Wales. Dobb's Linn, Hartfell, Glenkiln Burn, Wanlockhead, etc., near Moffat, Dumfriesshire. Loch Ryan, Wigtownshire. *Caradoc*:—Canada and New York (Hudson River Group.) Also recorded by Professor McCoy, from the Coniston Flags, near Ulverston, and from the Lower Silurian rocks of Melbourne, etc., Australia; and by Dr. Emmons (*inequalis*) from Tennessee.

EXPLANATION OF PLATE XVI.

Fig. 1. *Dicranograptus sextans*, Hall. 1*a*. A specimen natural size. 1*b*. The same magnified 5 diameters (restored). 1*c*. The proximal end of another specimen slightly enlarged (from a drawing by Dr. H. A. Nicholson).

Fig. 2. *Dicranograptus formosus*, Hopk. 2*a*. A specimen nat. size. 2*b*. and *c*. Portions of different specimens mag. 5 dia. 2*d*. A piece of shale (from the Beld Craig Burn) covered with impressions.

Fig. 3. *Dicranograptus Nicholsoni*, Hopk. 3*a*. A specimen nat. size. 3*b*. The proximal end of the same mag. 5 dia. 3*c*. A specimen from the collection of Mr. Carruthers, nat. size. 3*d*. Part of a branch of the same mag. 5 dia.

Fig. 4. *Dicranograptus Clingani*, Carr. 4*a*. A specimen nat. size. 4*b*. The same mag. 5 dia. 4*c*. Part of a branch of another specimen, mag. 5 dia.

Fig. 5. *Dicranograptus ramosus*, Hall. 5*a*. A specimen nat. size. 5*b*, *c*, and *d*. Portions of the branches of the same mag. 5 dia. 5*e*. A portion of another specimen mag. 5 dia.

III.—ON ITALIAN TERTIARY BRACHIOPODA.

BY THOMAS DAVIDSON, F.R.S., F.G.S., ETC.

(PLATES XVII AND XVIII.)

FOR many years past I have, at intervals, devoted attention to Tertiary Brachiopoda, and I now propose to note down some remarks in connection with those of Italy.

Of all countries hitherto investigated, Italy has afforded the largest number of species, and of these I have been able to study the best collections, as well as many examples of those which have been found in the South of France, in Spain and in Algeria. The study of Tertiary species in conjunction with those still existing is a subject of considerable interest, and it did not fail to attract the attention of our justly-celebrated geologist Sir Charles Lyell at the very dawn of his geological career, and it is mainly to his travels, and admirable researches, and to the publication of the third volume of his renowned "Principles of Geology" in 1833, that we are indebted for the first clear light that has been thrown upon the subject of Tertiary geology. In 1829 (as stated in his preface) Sir C. Lyell had, after repeated journeys in Italy and in other regions, arrived at the conclusion that the Tertiary period might be conveniently subdivided into three or four principal divisions, for which he invented the designations of *Eocene*, *Miocene*, older and newer *Pliocene*—these divisions being founded on the relative number of species in each group which were identifiable with species now living.

In 1830 Sir C. Lyell became acquainted with the eminent French conchologist, M. Deshayes, who had, previous to his introduction to Sir Charles, been arranging the numerous Tertiary shells in his possession into three groups, which, in the main, agreed with the divisions arrived at by our English geologist after several years of labour in the field; and, in order to give greater weight to these divisions, Sir Charles induced M. Deshayes to prepare a series of tables to be appended to the third volume of the "Principles" already quoted.

Sir Charles Lyell and M. Deshayes were, however, perfectly aware in 1833 that the per-centage test would continually require modification, as every fresh discovery would, in a measure, alter the numerical results they had provisionally published; but they also felt that the main fact would remain unaltered, namely, that as our Tertiary formations approach in age to the recent period, they will be found to contain a larger proportion or per-centage of living forms. Moreover, as was surmised by Sir Charles himself, geologists would subsequently find it necessary to subdivide each of his large divisions into two, three, or more stages. Indeed, as has been so often observed by geologists as well as by palæontologists, lines of demarcation are established more for convenience of reference than in order to denote any absolute interruption in the regular sequence of sedimentary deposition, or of life on the surface of our globe. These supposed breaks are very often due to local conditions, which may occur in one and not in another field of observation. We are likewise far from having discovered the laws which regulate the gradual succession of life; and we are, I fear, much too apt to guess at the origin of species, and to interpret those unknown laws from a small number of incomplete observations. The assiduous researches which for many years I have made among the living and fossil species of Brachiopoda, have to a certain extent imbued my mind with the idea that an individual species may have been gradually very much modified in time so as to suit the conditions under which it had to exist, but at the same time everyone who has studied with any degree of care any class composing the animal kingdom, must frankly admit that there are so many inexplicable sudden appearances of entirely distinct forms, with no apparent links, connecting them with those that were antecedent, or even contemporaneous, that it is impossible, in the present state of our knowledge, to arrive at any definite conclusions. To what extent species are derived from their predecessors, is a problem which may, or may never be completely explained, but it is so sublime a subject of investigation, that every new fact acquired is of the highest value to the intellectual observer.

It will not be possible or necessary here to enter into any lengthened discussion relative to the views entertained by different geologists in connection with the number of stages into which the Tertiary period should be divided, or as to the names which each of these should retain; but we cannot go far wrong in grouping the Italian Brachiopoda into the following well-known divisions:—

Recent.
Quaternary.
Tertiary period. 3 { Upper Pliocene.
Lower Pliocene.
2 { Upper Miocene.
Middle Miocene.
Lower Miocene.
1 Eocene or Nummulitic.
Cretaceous (Scaglia of the Italians).

We may, however, mention, prior to entering upon the main subject of this communication, that in his "*Tableau Synchronistique des Terrains Tertiaires,*" published in 1868 and 1869, Mr. Ch. Mayer, of Zurich, has divided the Tertiary period into the following fourteen separate stages:—

Upper Tertiary.	XIV.	Étage Saharien	= Saharian series, 1865.
	XIII.	Étage Astien	= Astian series, 1856.
	XII.	Étage Messinien	= Messinian series, 1867.
	XI.	Étage Tortonien	= Tortonian series, 1867.
	X.	Étage Helvétien	= Helvetian series, 1857.
	IX.	Étage Langhien	= Langhian series, 1866.
	VIII.	Étage Aquitanien	= Aquitanian series, 1867.
Lower Tertiary.	VII.	Étage Tongrien	= Tongrian series, 1852.
	VI.	Étage Ligurien	= Ligurian series, 1857.
	V.	Étage Bartonien	= Bartonian series, 1857.
	IV.	Étage Parisien	= Parisian series, 1857.
	III.	Étage Londonien	= Londonian series, 1857.
	II.	Étage Soissonien	= Soissonian series, 1857.
	I.	Étage Flandrien	= Flandrian series, 1868.

The Eocene deposits of the North of Italy have been carefully studied by several geologists; but, from want of space, I must refer the student for details upon this subject to the admirable memoir by Dr. Suess, published in the Proceedings of the Italian Society of Natural Sciences for the Meeting held at Vicenza, Venetia, in 1869, as well as to M. Bayan's excellent paper on the "Terrains tertiaires de la Vénétie," published in the Bulletin of the Geological Society of

France, 2nd ser. vol. xxvii., p. 444, March, 1870. In this communication M. Bayan divides the Eocene of the Vicentin territory into six stages, which he distinguishes by the letters A, B, C, D, E, and F. The stage A is divided into two series of beds, of which the lowest, with *Pentacrinus*, occurs at Mossano, etc. Above this he places those reddish compact limestones which at Monté Spilecco contain *Rhynchonella polymorpha*, etc. These beds had been considered by Baron Schauroth as forming part of the Cretaceous series; but as they lie above the Chalk (or "Scaglia," of the Italians) would be referred by M. Bayan and Sig. Meneghini to the lowest portion of the Tertiary period of that part of Italy. It represents also Dr. Suess's Horizon of Spilecco. In stage B, M. Bayan places *Rhyn. Bolcensis* and other species to which I will refer in the sequel, as that gentleman and Sig. Meneghini have placed their entire collection of Eocene Brachiopoda in my hands for examination and publication.

I must also mention that in the paper above referred to, M. Bayan divides the "Oligocène" period of Italy into two stages, G and H, reserving the letters I, J, and K, for the Miocene; but Sir C. Lyell informs me that he considers Prof. Beyrich's "Oligocène" to be synonymous with part of his own Lower Miocene.[1]

The Cavaliere Rovasenda of Turin tells me likewise that those who have made a lengthened study of the Geology of Piedmont, have been led to divide the Miocene into three stages, and to attribute great importance to the Middle Miocene; that, on the contrary, the Geologists of Central and Southern Italy, as well as strangers, do not appear to attach so much value to the Piedmontese Middle Miocene, for the reason that it is very difficult to form an exact idea of the thickness and importance of this stage, the best fossiliferous localities being little known, and of difficult access, but that the great bulk of his magnificent series of fossils were derived from it. In the hill of Turin, the Middle Miocene attains the greatest thickness, while the Lower and Upper Miocene is much less developed. Sig. Sequenza has also been led to attribute great importance to the Lower Pliocene, and proposes to substitute the term "Zancleano" for that of Older Pliocene.

I must now proceed to announce that the study of Italian Tertiary Brachiopoda has at intervals since 1759 attracted the keen attention of Italian Palæontologists, who have themselves well described and illustrated the larger number of their species, but in no separate paper or work have they been hitherto combined, and several of those from the Eocene period remain undescribed.

In 1759 Scilla illustrated two Sicilian species; in 1814 Brocchi described and figured some few forms he had found in Tuscany. In 1836 and 1844 several Calabrian and Sicilian species were described and illustrated by Philippi. In 1851 and 1852 Costa published those known to him from the kingdom of Naples; Sig. Michelotti, in several excellent works, described the few species found by him in Piedmont, but by far the larger number of these last, as well as of those from Sicily, have been well described and illustrated by Prof. Sequenza, of Messina. The species of the North of Italy and of Tuscany have also been carefully studied by Sig. Meneghini, of Pisa. Smaller contributions have likewise been made by Massalongo, Aradas, Calcara, Galvani, Biondi, Schauroth, Suess, and some others, whose names and works will be referred to in the sequel.

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[1] M. Deshayes still persists in attaching the "Oligocène" to the Lower Tertiary period, while the Germans, who possess the largest development of the series, are unanimous in considering it as an independent and intermediate period, lying between the Eocene and Miocene.

I propose, therefore, in this communication to review briefly the whole subject, and to furnish the student with descriptions of the new species, as well as some observations where necessary in connection with those already known. I also propose to add a figure or more of each species which, with few exceptions, I have drawn from well-preserved specimens, for which I am indebted to several of the gentlemen above named, in addition to the Cav. L. Rovasenda, of Turin, and Sig. Rigacci, of Rome. I would also refer the student to the works of the palæontologists above named for descriptions and lists of references, synonyms, etc., which, from want of space, cannot be transcribed in this paper. The larger number of the Eocene specimens figured by me belong to Sig. Meneghini, to the Museum of Pisa, and to that of the École Impériale des Mines, of Paris.

Italian Tertiary Brachiopoda.

Species.	Author.	Eocene.	Lower Miocene.	Middle Miocene.	Upper Miocene.	Older Pliocene.	Upper Pliocene.	Quaternary.	Recent.
Terebratula grandis	(Blumenbach)	...	...	...	x	x	x	...	...
var. *ampulla*	(Brocchi)	...	...	...	x	x	x	...	...
Regnolii	(Meneghini, M.S.)	...	...	...	x	...	...	...	...
,, *sinuosa*	(Brocchi)...............	?	...	x	x	x	...	...	...
Pedemontana	(Lamarck)......	...	...	...	x	...	...	...	...
,, *Roncionii*	(Meneg., M.S.) ...	...	...	...	...	x	...	...	...
,, *bisinuata*	(Lamarck)	x	...	...	...	...	...	...	...
,, *biplicatæformis*	(Schauroth)..	x	...	...	...	...	...	...	...
,, *Bayaniana*	(Davidson)	x	...	...	...	...	...	...	...
,, *Sequenziana*	(Davidson)	x	...	...	...	...	...	...	...
,, *vitrea*	(Born)	...	...	?	?	x	x	x	x
,, *minor*	(Philippi and Suess)	...	...	...	?	x	x	x	x
,, *Lyelliana*	(Sequenza)	...	...	...	...	...	x	...	...
,, *Benoitiana*	(Sequenza)..........	...	...	...	...	x	...	...	...
,, *elliptica*	(Sequenza)............	...	...	...	...	x	...	...	...
,, *Michelottina*	(Sequenza)......	...	...	...	x	x	...	...	...
,, *orbiculata*	(Sequenza)	...	...	...	...	x	...	...	...
,, *Rovasendina*	(Sequenza)	...	...	x	...	...	...	...	...
,, *Meneghiniana*	(Sequenza) ...	...	...	...	...	x	...	...	...
,, *sphenoidea*	(Philippi)	...	...	?	...	x	...	...	...
,, *Galeottina*	(Davidson).........	...	...	x	...	...	...	...	...
,, *miocenica*	(Michelotti)	...	...	x	...	...	...	...	...
,, *anceps*	(Michelotti)	...	...	...	x	...	...	...	...
,, *Voglinaci*	(Michelotti)	...	x	...	...	...	...	...	...
,, *rhomboidea*	(Biondi)	? x	...	...	...	...	...	...	...

Species. Author.	Eocene.	Lower Miocene.	Middle Miocene.	Upper Miocene.	Older Pliocene.	Upper Pliocene.	Quaternary.	Recent.
Terebratulina caputserpentis (Linné) ...	?	x	x	x	x	x	x	x
" *striatula* (Sow ?)	x	...	...	...	...	...	...	...
" *Tauriniensis* (Sequenza)......	...	...	x	..	...	...	...	...
" *Michelottina* (Davidson)	x	...	...	...	...	...	...	...
Waldheimia ? Hilarionis (Meneghini, M.S.)	x	...	...	...	...	...	...	...
" *septigera* (Loven) = *peloritana* (Sequenza)	...	...	x ?	...	x	x	x	x
" *cranium* (Muller) = *euthyra* (Philippi)...............	...	...	...	...	x	x	x	x
" *Davidsoniana* (Sequenza) ...	...	...	...	...	...	x	...	...
? *depressa* (Sequenza)...........	...	...	...	...	x	...	...	...
Terebratella septata (Philippi)	...	...	?	...	x	x	...	...
? *Spinellii* (Meneg., M.S.)	x	...	...	...	...	...	..	...
Megerlia truncata (Linné)	...	...	x	x	x	x	x	x
" var. *oblita* (Michelotti)..... ...	...	...	x	...	...	...	...	...
" *orbicularis* (Meneghini, M.S.)	...	...	...	x	..	...	...	...
Platidia (Morrisia) *anomioides* (Scacchi)	...	...	...	...	x	?	?	x
" (Morrisia) *Davidsoni* (Deslongchamps)	...	...	...	...	...	...	...	x
Argiope decottala (Chemnitz)	?	x	x	x	x	x	x	x
" *lunifera* (Philippi = *cistellula* (Wood)	...	...	...	...	x	?	x	x
" *lævis* (Sequenza)	...	...	x	...	...	...	...	...
" *costulata* (Sequenza)	...	...	x	...	...	...	...	...
" *cuneata* (Risso)	...	...	...	...	...	...	x	x
" *Neapolitana* (Scacchi).........	...	...	...	...	...	x	x	x
? *Rovasendina* (Davidson)......	...	x	...	..	...	...	...	...
Thecidium Mediterraneum (Risso).........	x	?	x	?	?	x	?	x
Rhynchonella Buchii (Michelotti)	...	x	x	x	..	...	..	...
" *polymorpha* (Massalongo) ...	x	...	...	...	...	...	...	...
" *bipartita* (Brocchi)	...	...	x ?	x	x	...	...	...
" and var. *plicato-dentata* (Costa)	...	...	x	x	x	...	...	...
" *Bolcensis* (Massalongo)	x	...	...	...	...	...	...	...
" *Meneghiniana* (Davidson) ...	x	...	...	...	...	...	...	...
" *complanata* (Brocchi)	...	...	x	...	...	...	...	...
" *sicula* (Sequenza, M.S.)	...	...	..	..	x	...	...	...
Crania Bayaniana (Davidson)	x	...	...	...	...	...	...	...
" *abnormis* (Defrance)	...	...	x	...	...	...	...	...
" *lamellosa* (Sequenza)	...	..	...	...	...	x	...	...
" *turbinata* (Poli)	...	...	...	...	...	...	x	x

1. *Terebratula grandis* (Blumenbach), Pl. XVIII., Fig. 1, 2. Pl. XIX., Fig. 1, 2, 3. This important species is exceedingly variable, it is usually more or less elongated, and some specimens are almost circular. It varies also in the degree of convexity of its valves. Specimens agreeing with those that occur in England, France, Spain, and Germany are found in the Upper Miocene, but are especially

abundant in the Pliocene of various parts of Italy. It may be collected at Casaglia near Volterra, Monale near Asti, etc., in Tuscany; at Monte Mario in Rome, in Calabria, and in the Island of Sicily.

To an inflated variety from the Piacentino (Pl. XIX., Fig. 2) Brocchi gave the name of *ampulla*, and he refers likewise to a figure by Scilla (De Corporibus Marinis, pl. xiv., fig. 6, 1759), but many palæontologists seem to be of opinion that this designation should be added to the synonyms of *T. grandis*. Sig. Meneghini believes, however, that he has detected some small modifications in the shape of the loop, which he thinks might perhaps entitle it to retain its separate designation. He proposes likewise the name of *T. Regnolii* for a circular shell (Pl. XIX., Fig. 3), from the Upper Miocene of Parlascio (Hills of Pisa), in which the crura and lateral branches of the loop would be more divaricated and the shell punctures more strongly marked than in either *T. grandis* or *T. ampulla*. Sig. Sequenza informs me that all the Sicilian specimens that were referred by him to *T. ampulla* are in reality referrible to *T. grandis*, and I am quite disposed to concur in this opinion. The shell under notice has not yet been discovered in the recent condition; the largest known recent *Terebratulæ* having elongated loops, as in *Waldheimia*.

2. *Terebratula sinuosa* (Brocchi), Pl. XVIII., Fig. 3, 4, 5. Brocchi refers us to the Encyclopédie Méthodique, pl. 239, fig. 3, for an illustration of his species, and on comparing this figure with similar small examples of *T. sinuosa* from Italy and the Island of Malta,[1] I found that they agreed completely, as well as with the typical example of *T. Pedemontana* (Lamarck), in the Museum of the Jardin des Plantes, of Paris,[2] so I am inclined to consider that all these shells may perhaps be variations in shape of a single species. Sig. Meneghini believes *T. Pedemontana* to be specifically distinct, both by the incurvation of its beak and shape of its loop.

T. sinuosa attains large dimensions, but not quite as great as *T. grandis*. It is very variable in shape, so much so, that at one time I felt inclined to concur in the opinion expressed by several palæontologists,—namely, that *T. sinuosa* might be nothing more than a biplicated variety of *T. grandis;* but having subsequently found that so many middle-aged and adult specimens attributed to *T. sinuosa* were always extremely biplicated, I became disposed to consider it as specifically distinct from *T. grandis*. Mr. Champernowne has likewise collected several specimens at Cordova, in Spain, which agreed in every respect with those so abundantly found in the Island of Malta, and I have also seen two or three examples from Algeria which presented the same peculiarities.

It is still uncertain when this species first made its appearance; an incomplete specimen (Pl. XVII., Fig. 3), obtained by Sig. Meneghini in Eocenic greensand at Belluno has, with some uncertainty, been attributed to the species. From the Middle Miocene it is quoted from Rosignano, near Casale and the Colle dei Cappucini, near Turin. *T. Pedemontana* is stated by Meneghini to occur only in the

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[1] Dav., Annals and Mag. of Nat. Hist. 2nd ser. vol. v., pl. xiv., fig. 34, 1850.

[2] Dav., Annals and Mag. of Nat. Hist. for July, 1864.

Upper Miocene of Palazzo and St. Lorenzo, near Siena. The same distinguished palæontologist informs me that he likewise obtained *T. sinuosa* in the Pliocene near Siena, and at the Grotta Rondinaya (Val d'Elsa), in Tuscany. Brocchi quotes it from the Piacentino, and it occurs in the same formation in Calabria and in Sicily, but has not hitherto been discovered in the recent condition.

3. *Terebratula Roncionii* (Meneghini, M.S.), Pl. XIX., Fig. 4. Ovate and biplicated only near the frontal margin, valves almost equally deep, surface smooth; length 10, width 8, depth 5 lines.

Sig. Meneghini found this shell in blue sub-Apennine clays (Pliocene) at Roncione (Hills of Pisa), but is uncertain whether it should be described as new. The shell is very remarkable on acount of the size and arrangement of its punctures. Its interior is not known.

4. *Terebratula bisinuata* (Lamarck ?) Pl. XVII., Fig. 1, 2. Lamarck. Histoire Nat. des Animaux sans vertèbres, vol. vi., p. 252, 1819.

Several specimens found by Sig. Meneghini in the Eocene or Nummulitic Limestone at Bolca, in the Veronese territory, have been referred by him to Lamarck's species. I have compared these shells with a large series of specimens of *T. bisinuata* from Parnes, near Paris, and have observed that in the French examples the biplication is usually less strongly defined than in those from Italy. I cannot, however, help noting how nearly some of these Bolca shells agree with similar sized specimens of *T. sinuosa*.

5. *Terebratula biplicatæformis* (Schauroth), Pl. XVII., Fig. 9. Verzeichniss der Versteinerungen im Herzogl-Naturalien Cabinet zu Coburg, p. 165, pl. v., fig. 3, 1865.

I know nothing of this species further than the description and figures published by Schauroth. It appears to be slightly biplicated in front, and is, consequently quite distinct from the *Ter. Fumanensis* of Meneghini; along with it is found a large variety of *Rh. polymorpha* =*T. contorta* (Schaffh.). It occurs in the lowest stage of the Eocene series at Novala, or rather at the Zovo di Castelvecchio, near Valdagno.

6. *Terebratula Fumanensis* (Meneghini), M.S, Pl. XVII., Fig. 6, 7, 8. Shell oval, longer than wide, broadest about the middle, ventral valve much more convex and deep than the opposite one; beak incurved and truncated by a circular foramen; dorsal valve slightly convex, flattened, and sometimes gently depressed towards the front. Surface smooth, marked by concentric lines of growth. Interior not known. Length 12, width 11, depth 7 lines.

This species is remarkable on account of its oval shape and small convexity of its dorsal valve. It occurs abundantly along with *Rh. polymorpha*, in a compact rose-coloured Nummulitic or Eocenic Limestone at Fumane, in the Veronese territory, also at Monte Spilecco near Bolca, the Zovo di Castelvecchio, Campo Tamaso, etc. This rock being about the oldest Tertiary deposit in the North of Italy.

7. *Terebratula vitrea* (Born), Pl. XVII., Fig. 11. This well-known species made its first appearance during the Miocene period, if it

is not, indeed, a descendant from the Cretaceous *T. carnea*, and from which it can at times be scarcely distinguished. It is abundant in the Older and Newer Pliocene of Sicily, is alive in the Mediterranean, and apparently likewise so in the Gulf of Mexico; for the *Ter. Cubensis* of Pourtales is evidently a synonym of the shell under notice. Small Sicilian (Pliocene) examples of *T. vitrea* were figured by Scilla in 1759, and it abounds in many places near Messina. It is found likewise in Quaternary deposits of the same district.

T. vitrea varies much, and several of its varieties or modifications in shape have been described as distinct species. *Terebratula minor* (Philippi), *T. elliptica*, *T. Benoitiana*, *T. Michelottina*, *T. Lyelliana*, and *T. orbiculata* (Sequenza), appear to me to be very nearly allied to *T. vitrea*; and further study with reference to their distinguishing characters will be required.

8. *Terebratula minor* (Philippi), Pl. XVII., Fig. 14. *T. vitrea*, var. *minor* (Philippi), Enumeratio Moll. Siciliæ, vol. i., pl. vi., fig. 8, 1836.

This small shell is exceedingly abundant in the Pliocene deposits of Sicily, and is pretty constant in its dimensions, which are considerably smaller than those of *T. vitrea*. In 1845 it received from Calcara the specific designation of *affinis*; Suess, in 1859, considered it to be specifically distinct from *T. vitrea*, and described it as possessing stronger valves and blunt margins, and he further observes, that Philippi had pointed out the constant differences between the two. Its loop is exactly similar to that of *T. vitrea*. This small species occurs alive near the Island of Lipari, north of Sicily, and in other parts of the Mediterranean.

9. *Terebratula Lyelliana* (Sequenza), Pl. XIX., Fig. 5. Sicilian Brachiopoda, vol. i. Memorie della Soc. Italiana di Scienze Naturali, p. 23, pl. i., fig. 11, 12, 13, 1865.

Externally this small shell much resembles *T. minor*; a slight difference in its loop is assigned to it by Sig. Sequenza. It occurs in the Upper Pliocene near Messina, and where it is rare.

10. *Terebratula Benoitiana* (Sequenza), Pl. XVII., Fig. 13. Sicilian Brachiopoda, pl. ii., fig. 10.

The interior has not been discovered, and exteriorly it bears much resemblance to some specimens of *T. vitrea*. It occurs in the Older Pliocene near Messina, where it is stated to be exceedingly rare.

11. *Terebratula elliptica* (Sequenza), Pl. XVII., Fig. 12. Sicilian Brachiopoda, pl. ii., fig. 11.

This shell is said to be very rare, and to occur in the Older Pliocene compact limestone of Gravitelli, Rometta, and Scirpi, in Sicily. Its interior is not known, and it much resembles certain specimens of *T. vitrea*.

12. *Terebratula Michelottina* (Sequenza), Pl. XVIII., Fig. 8. Sicilian Brachiopoda, pl. ii., fig. 7, 8, 9.

This shell is stated by Sig. Sequenza to be easily distinguishable from *T. vitrea* by its circular shape, as well as by certain small differences in the hinge-plate. It occurs in the Upper Miocene and Lower Pliocene near Messina.

13. *Terebratula orbiculata* (Sequenza), Pl. XVII., Fig. 15. Sicilian Brachiopoda, pl. ii., fig. 7, 8, 9.

Sig. Sequenza considers this shell to bear much external resemblance to the preceding one, but that it differs from it in some small detail in the shape of its loop. It occurs in the Lower Pliocene at Rometta, Scoppo, and Gravitelli, near Messina.

14. *Terebratula Meneghiniana* (Sequenza), Pl. XVII., Fig. 18. Sicilian Brachiopoda, pl. ii., fig. 12, 13.

This is a very distinct and remarkable species, on account of the median depression observable in the anterior portion of its dorsal valve, as well as from the numerous equidistant prominent concentric ridges which ornament its surface. It occurs in the Lower Pliocene of Rometta and Scirpi, near Messina.

15. *Terebratula sphenoidea* (Philippi), Pl. XVII., Fig. 16. Enumeratio Moll. Siciliæ, vol. ii., pl. xviii., fig. 6, 1844.

This species varies considerably in shape, but is distinguishable from *Ter. vitrea* by several characters. It is usually widest about the middle, most convex posteriorly, and flattened in both valves from the centre to the front. It has been stated with uncertainty to occur in the Middle Miocene of the Monte dei Cappucini and Gassino, near Turin, also at Saravalle di Scrivia; but the specimens in question, which were lent me by the Cav. Rovasenda, appeared referrible either to *Waldheimia septigera* or to *Terebratella septata*, on account of the dark line they exhibit along the dorsal valve, from the umbo to about the middle of the valve, which indicates the internal presence of a septum, which *Terebratula sphenoidea* does not possess. Sig. Michelotti states likewise that he has found it at La Bonetta, in Piedmont. *T. sphenoidea* occurs abundantly in the Older Pliocene of Messina and Calabria.

16. *Terebratula Rovasendina* (Sequenza), Pl. XVII., Fig. 10. Brachiopodi Miocenici. Annali dell Accad. degli aspiranti Naturali di Napoli. Third series, vol. vi., pl. i., fig. 1, 2, 3, and pl. ii., fig. 1, 1866.

This appears to be a good species, which Sig. Sequenza describes as intermediate in character between *T. ampulla* and *T. vitrea*. It is a compressed shell, with a broad, slightly prominent, and flattened mesial fold, and has been well described and illustrated by Sequenza from a superb series of specimens collected by the Cav. Rovasenda from the Middle Miocene near Casale, Baldissero; and Termo-Foura near Turin.

17. *Terebratula Galeottina* (Dav.), Pl. XIX., Fig. 6, 7.

Shell small, ovate, longer than wide, rounded laterally, nearly straight in front. Ventral valve convex, somewhat carinated along the middle, beak small, incurved and truncated by a large foramen. Dorsal valve moderately convex, much less deep than the opposite valve, flattened or slightly depressed near the front. Surface smooth, or rather faintly marked with fine radiating striæ. Shell punctures rather large. Interior not known. Length 6, width 5½, depth 3 lines. This species differs from *T. minor*, with which it may be ıetimes confounded, in having a slight depression near the front ts dorsal valve, while in *T. minor* this same portion of the valve artly convex. It was found by the Cav. Rovasenda in the Middle ıcene of Gassino, on the Po, near Turin.

8. *Terebratula Miocenica* (Michelotti), Pl. XVIII., Fig. 6. Précis la Faune Miocene de la Haute Italie. Harlem, 1847, pl. xvi., 1.

know very little about this species, it bears some resemblance to *vitrea*, but has a large foramen. It occurs in the Middle Miocene Javi and of Serravalle di Scrivia.

9. *Terebratula anceps* (Michelotti), Pl. XVIII., Fig. 7. Same work ıbove, pl. xvi., fig. 3.

Very little satisfactory seems to be known with reference to this cies; Sig. Michelotti states it to be inequilateral and oblique; may this not be due to malformation or to the imperfect state of specimens? It is said to be rare, and to occur in the Upper ocene of St. Agata near Tortone, in Piedmont.

10. *Terebratula? Bayaniana* (Dav.), Pl. XVII., Fig. 17.

Shell small, obtusely five-sided, slightly longer than wide, broadest ut the middle, straight in front. Valves moderately convex, tened along the middle with a slight depression towards the front; k small, incurved and truncated by a circular foramen lying close the umbo of the dorsal valve. Surface smooth, marked with a concentric lines of growth. Interior not known. Length 4, adth 3½, depth 2 lines.

This small species much approaches by its shape to some examples *Waldh. tamarindus*, but has not the curved frontal line so generally ervable in the Cretaceous species. It was found by M. Bayan at ca, along with *Rh. Bolcensis* and *Rh. polymorpha*, in a friable lowish tufa (his stage G), and which would be perhaps a little her up in the geological scale than are those beds which at ca contain *Ter. Fumanensis*. It belongs to the Eocene period.

11. *Terebratula Sequensiana* (Dav.), Pl. XVII., Fig. 19, 19*a*. Shell ıte, or longitudinally oval, widest about the middle, sides and ıt rounded, dorsal valve convex, most so along the middle. ıtral valve slightly deeper than the dorsal one, with a median ression or concave sinus commencing at about the middle of the ve and extending to the front; beak small, incurved and truncated by a circular foramen. Surface marked with numerous close, slightly visible, longitudinal, radiating striæ, which are here and re crossed by concentric lines of growth. A large specimen asured: length 7, width 5, depth 4 lines.

This species is remarkable on account of its oval shape and con-e depression towards the front of its ventral valve, but especially from the numerous small radiating striæ which ornament its sur-e. Sig. Meneghini and M. Bayan consider it to be referrible the highest bed of the Eocene, while Sig. Michelotti and M. urnouer would place it at the base of the Lower Miocene. It urs at Crosara near Lugo, and at Brendola with Nummulites, *Orbitiodes*, etc. M. Bayan found it in his stages F and G, along with *Rh. Bolonis*, in the bed of the Laverda. It is quite distinct from *Terebratulina tenuistriata* (Leymerie), with which it has been sometimes confounded.

22. *Terebratula Guiscardiana* (Sequenza), Pl. XVIII., Fig. 9. Sicilian Brachiopoda. vol. i., Memorie della Societa Italiana di Scienze Naturali, pl. iv., fig. 6, 7, 1865.

This is a very remarkable cuneiform shell, being broadest anteriorly, rounded in front, and tapering to the beak. The valves are almost equally deep and bent inwards round the border, so that in old individuals there is a deep indenture all round the margin. The surface is strongly marked by prominent concentric lines of growth, and radiating zig-zag raised lines. The foramen is large and the beak scarcely incurved. It occurs in the Lower Pliocene (Zancleano) of Messina.

(*To be continued.*)

EXPLANATION OF PLATES XVII. AND XVIII.

PLATE XVII.

Figs. 1, 2. *Terebratula bisinuata* (Lam.), Eocene, Bolca, collection of Sig. Meneghini.
3. *Terebratula sinuosa* (Brocchi ?), Eocene, Belluno, same collection.
4, 5. *Waldheimia Hilarionis* (Meneg.) MS., Eocene, St. Jean Hilarione, same collection.
6, 7, 8. *Terebratula Fumanensis* (Meneg.), Sp., Eocene. 6. Mus. E'cole des Mines, from the Zovo di Castelvecchio. 7, 8. From Fumano, Mus. of Pisa.
9. *Terebratula biplicatæformis* (Schauroth), Eocene, Novala, after Schauroth's figures, Mus. of Coburg.
10. *Terebratula Rosavendiana* (Seq.), Miocene, Rosignano, etc., collection of Sig. Rovasenda.
11. *Terebratula vitrea* (Born), Pliocene, Messina.
12. *Terebratula elliptica* (Seq.), Older Pliocene, near Messina, after Sequenza.
13. *Terebratula Benoitiana* (Seq.), Older Pliocene, after Sequenza.
14. *Terebratula minor* (Philippi), Pliocene, near Messina.
15. *Terebratula orbiculata* (Seq.), Older Pliocene, Messina, after Sequenza.
16. *Terebratula sphenoidea* (Philippi), Older Pliocene, Messina.
17. *Terebratula Bayaniana* (Dav.), Eocene, Bolca, Mus. of the E'cole des Mines, Paris. 17*a* enlarged.
18. *Terebratula Meneghiniana* (Seq.), Lower Pliocene, near Messina.
19. *Terebratula Sequenziana* (Dav.), Eocene, Crosara. 19*a* enlarged.

PLATE XVIII.

1, 2. *Terebratula grandis* (Blum.) 1. Older Pliocene, Messina. 2. Pliocene, Tuscany. Collection of Sig. Meneghini.
3. *Terebratula sinuosa* (Brocchi), figure taken from the Encyclopédie Méthodique, pl. 239, fig. 3.
4. *Terebratula sinuosa*, Middle Miocene, Baldissero, collection of Sig. Rovasenda.
5. *Terebratula Pedemontana* (Lamarck), Upper Miocene, Tuscany, from the type in the Museum of the Jardin des Plantes.
6. *Terebratula miocenica* (Michelotti), Miocene, Gavi, after Michelotti.
7. *Terebratula anceps* (Michelotti), Upper Miocene, St. Agata, after Michelotti.
8. *Terebratula Michelottini* (Seq.), Upper and Lower Pliocene, Messina.
9. *Terebratula Guiscardiana* (Seq.), Lower Pliocene, Messina.

NOTICES OF MEMOIRS.

I.—On the Primæval Rivers of Britain.[1]

By T. Rupert Jones, F.G.S., Professor of Geology, etc., Royal Military College, Sandhurst.

THE geological action and results of rain and rivers may be easily recognized by even casual observers. The muddy waters of a clay country after showers, and the numerous little deltas of rain-washed grit and mud on the slopes of roads and fields where sandy soil abounds, attest the action of the rain in removing earthy material from a higher to a lower level, under ordinary circumstances. The powerful action of torrents suddenly charged with melted snow or with tropical rains, or locally flooded by a bursting water-spout, is well known, and can be likened only to the devastating agency of a broken reservoir, such as those of Huddersfield and Sheffield. In all cases mud, sand, and shingle, together with drifted timber, herbage, leaves, and water-plants, bones and carcases, insects, shells of land and water molluscs, and other organic remnants, are slowly or suddenly moved down-stream,—laid down here, stirred up and pushed forward there,—buried deeply at one place, ceaselessly drifted to and fro at another; and such changes go on until the river-plain, having been made level by marsh-deposits, and excavated repeatedly along the wandering lines of the river's changing course, extends seaward; and the delta pushes out even into the sea, which takes more and more of the mingled detritus for its share, laying it down in the deeps and the shallows with a seemingly capricious irregularity, which is, really, recognizable order, dependent on the gravity of particles and the force and direction of tides and currents.

By its alluvium, or deposits of gravel, sand, and mud, often blackened with peat or charged with shells and bones, the river keeps an imperfect record of its work, as a carrying agent, in removing the ruins of the higher ground, whether reduced by the chipping frost and the grinding glacier, by the soaking mists and sapping springs, by the washing rain and raging torrents, or by all of these, assisted by the slow and sure decomposing power of carbonic acid. As a red river runs from red ground, so does a muddy river come from clay ground, and a hard-water river from limestones. The shingle of slate or quartz-rock, of granite or mica-schist, of sandstone or limestone, bears direct evidence of its local origin; and the sand from old sandstones, from the quartz of granite newly rotted, or from the frost-bitten quartz-rock, still shows traces of its birth-place. Whether in lakes or seas, such detritus tells of its former belongings, and is subject to unchangeable laws of deposition and arrangement. Clay may have been fine mud derived directly from the decomposition and degradation of felspathic rocks, or from the wear and tear of clay-slates, shales, and other argillaceous rocks; but in any case the river carries it in suspension until the current is checked in the still water of a lake, or of a broad reach or bend of the river, or in the sluggish delta-streams where they commingle with the sea. And even here the sweeping tides may drive on the clay-stained waters for many a league, until, transferred to the quiet of a land-locked bay, they drop their sediment, or, borne out to depths where nothing else can reach but drift-wood and floating shells from shore, it slowly sinks among the creatures of the deep.

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[1] Being the substance of a lecture given at Southerndown, July 20th, 1869. Reprinted from the Proceedings of the Cardiff Naturalist's Society.

Where clay has settled near a river's mouth, it is often associated with the decaying marsh-plants, drifted trees, and the water-logged leaves of successive autumns. Where rain-floods and freshets of snow-water have periodically deluged the river's course, the sediment will include the carcases and bones of drowned land animals, and the mud-choked water-creatures that lived at and near its mouth.

What rivers do now they have always done, since the land began to be drained of atmospheric waters along the cracks and crevices of the strata, and the old creeks and arms of the retiring seas. Whether the ground was left by the sea as flats and table-lands, planed horizontally by "marine denudation," or still rugged with the inequalities of crumpled strata crushed upwards by the contracting crust, the air, rain, snow, and frost have had to reduce the elevated and to fill up the hollow surface. And amidst the many changes that this terraqueous globe has suffered (changes due mainly, perhaps, to the reaction of internal heat on a cooling and contracting crust, with its shifting loads of water-borne sediments), such varied deposits as those of everchanging river-systems, rising in the high lands, lifted up in each successive period, and depositing their loads of mud as stratified sediments in the corresponding water-areas, were always being made and often swept away again, but sometimes buried under other strata and kept as part of the stratified series, as we see it now.

The characteristic sign of fluviatile and lacustrine strata have been indicated above, and the kinds of shells, such as *Paludina*, *Limnæus*, *Planorbis*, *Cyrena*, *Cyclas*, *Unio*, *Anodon*, etc., are well known. So also *Cypris* and *Estheria* among the low crustacea have left their carapace-valves in the silts of fresh or brackish waters. Fishes are not good witnesses; for many genera and even species of fish inhabit both rivers and sea, and may be imbedded in the mud of either. Accumulations of vegetable matter (especially land plants) are more likely to occur in lakes and rivers than in the sea; and the skeletons of land animals get dissipated as separate bones in most instances before they reach the sea. In Shells, Corals, and Encrinites we have the best criteria for judging of the origin of strata. There are fossil beds of shells, such as *Paludina*, that are never known to live in the sea; and there are others, as *Ostrea*, that flourish only in salt water, though some individuals may have a struggling existence in brackish estuaries. Others, as *Venus* and *Turritella*, are sea-shells. Of Entomostraca, *Cythere*, *Bairdia*, *Leperditia*, and others are habitually marine. Of Corals there are none that live in rivers or lakes; and all fresh waters, too, are destitute of Echinoderms, whether Starfishes, Encrinites, or other forms, as well as of Foraminifera, the microzoa so abundant in the fossil state. Take limestones (a various group, comprising chalk, oolite, common limestone, and marble), with the exception of a few that have originated from the chemical arrangement of carbonate of lime, as travertine, all have been made up of organic remains, namely, the calcareous shell or crust, or other support of some of the creatures above mentioned—mostly Shells, Corals, Encrinites, and Foraminifera; and only occasional bands of limestone made of fresh-water shells (*Paludina*, *Cyrena*, etc.) are found. They tell, however, plainly of their local origin, and are associated with equally powerful and distinct witnesses of the extent and influence of rivers and lakes deltas and lagoons, at many, if not all, periods of the earth's history.

The chief examples of such evidences as are retained among the known strata, in different parts of the world, will now be noticed in a brief review of the several great groups of geological formations.

The oldest known strata are the Laurentian, formerly involved in the little understood mass of old schists, slates, and gneiss lying below the Cambrian rocks, but of late years disentangled by Logan and others, and recognized as crumpled beds of masked and altered sandstones, shales, and limestone, such as constitute any of the later formations. They contain also some thin bands of graphite; and if this be altered coal, that was accumulated (like the later coal) in salt marshes and lagoons, the existence of land and its concomitant conditions is indicated thereby. In other respects the Laurentian strata appear to be of truly marine origin, with shingle and sand-banks of the coasts, and calcareous formations of the deep water.

The Cambrian rocks have not yet presented evidence of the existence of rivers or lakes. Land, however, there was; for sand-banks under tidal influence were rippled and sand-cracked, drilled and furrowed by shore-worms and small crustaceans, and pitted by rain-drops. They imbedded here and there the sea-weeds, and, if some decide truly, land plants also (*Eophyton*). The Silurian strata are also wholly of marine origin as far as is known; but in the uppermost formation (the Passage-beds or Ledbury Shales) land plants were brought into the shallows or estuaries, possibly by streams, and remain for us to examine as twigs, branches, spore-cases of Lycopodiaceous plants (*Lycopodites*, *Pachytheca sphærica*). These Passage-beds lead us into the Old Red Sandstones of Herefordshire and Scotland; and for these Mr. Godwin-Austen has strongly argued a freshwater origin. That freshwater conditions did predominate when a part at least of the Old Red of Caithness was formed, the multitudes of *Estheria membranacea* attest; and *Anodon Jukesii* in the Upper Old Red of Ireland speaks of similar conditions. Wide regions were certainly occupied then as forest-land and by jungle-growth, with Conifers and Cryptogams, whence originated the plant-beds of New Brunswick and the coal of Gaspé. Coniferous trees, too, were not wanting in the Scottish area; and in either case were probably washed down by rivers to the salt-marshes, with the sand, mud, and vegetable débris that form the associated sandstones and shaly layers.

On a still larger scale the succeeding period witnessed the action of rain and rivers. These nourished a rich vegetation and swept it away, to be buried beneath like material again and again, jungle on jungle, time after time, as the lagoon became a marsh, the marsh a forest, the forest a ruin of trees, silted up with river mud, and buried beneath sea sand, but succeeded again by marsh, and soil, and trees. The streams played their part in this old land. It was rich with trees and ferns, and the great congeners of our small club-mosses and horsetails, and furnished with land-snails, myriapods, arachnids, and insects in abundance; reptiles too, great and various, were there, and possibly birds and mammals. The stream cutting through the older beds of peat and the coal brought down the tribute of the higher ground, flooded the forests and gradually filled the sunken areas. Basins also, barred off from the sea by shingle banks, were thus made into brackish lagoons, full of marsh-plants, and alive with reptile, fish, crustacean and mollusc, that made the foul water and black mud their home.

In the "Rothliegende" of the Permian Series we again find *Estheria* and Dreissena-like Molluscs that indicate brackish habitats. The Permian breccia of Worcestershire has been referred to a glacier for its origin; and so also some of the conglomerates of the Old Red series, and even of the Cambrian, have been thought to have originated in such an ice-river of the ancient lands.

In the New Red Sandstone series of Germany the shaly coal, called "Lettenkohle," is of fresh-water origin; and the same *Estheria minuta* that abounds therein occur also in the "Keuper" or Upper New Red of Worcestershire, with fragmentary plant-remains. In the succeeding Rhætic strata the influence of occasional rivers and lakes is seen in the drifted land plants and insects, and the interpolated Estherian beds of Gloucestershire, Somersetshire, and elsewhere. The Lias of the Banat (Austria) has abundance of terrestrial plants, forming a coal; but here in the west the fossil trees and leaves of the Lias are but waifs and strays, and were washed to sea with the bones of the great *Scelidosaurus*; and the sudden river floods must have killed by the million successive generations of fishes, Ammonites, and Belemnites, and buried them in thick new mud, together with the unhurt carcases of the associated Ichthyosaur and Plesiosaur. These last have their skin and bowels intact; the molluscs were imbedded with the animal in the shell, and the cuttles retain even their inkbags unemptied, for death was quicker than their fear. Melting snow produces such sudden floods in temperate climates, and the monsoons on the eastern coast of India supply such abundance of fresh water, as to kill the sea-fish in myriads.

During the time that the Oolitic formations were being laid down, some rivers ran into the sea from the west (the direction that all the older rivers also had in this region probably, as the old land lay where the North Atlantic and parts of North America are now), and we find traces of their influence in the Brora coal and the Moorland coal of Yorkshire, and further south in the plant-bearing sandy shales of Collyweston, and in somewhat similar laminated oolite at Stonesfield. In the last-named beds, which supply a roofing-stone, bones of land animals have long been known to occur, especially the lower jaw-bones, such as fall off from floating carcases in rivers, as Dr. Buckland pointed out to be the case with dead dogs washed down towards the mouth of the Thames. The *Megalosaurus* then lived upon the land, as we know by his bones having been washed into the neighbouring sea.

When we examine the Purbeck strata, lying on the Portland Oolite, we find thick beds of limestone formed of shells that lived in lake and estuary; and in one particular bed, mis-named a "dirt-bed," but really an old lake-deposit, hundreds of bones have been found by Messrs. Beckles and Brodie, that belonged to the land mammals and reptiles of small size and various kinds, herbivores, carnivores, and insectivores. The river-system that gave rise to the Purbeck beds came from the west, as did the older rivers from the old land; and it continued in a modified form, and made the delta-beds, mud-banks, sand-shoals, and lagoon-deposits, sometimes full of vegetable matter, that are known as the Wealden formation. The Megalosaur lived on, with the Iguanodon, Hylæosaur, and other monster reptiles of the times; and they not only left their drowned carcases as evidences of their existence, but their foot-tracks remain on the marshy banks now converted into sand and clay; and these are often full of *Paludina*, *Cyclas*, *Unio*, and other such-like shells, with ferns and cycads, and other spoils of land and river. Similar deltas and lagoons existed in Europe and America, with the allied or analogous inhabitants of the different regions. The sea again asserted its dominion over these areas, and deposited the various Cretaceous strata, until, by the silting up of the hollows, and by local elevations, land was again formed, with its marshes, lakes, and rivers. Of these the lignites and wonderfully-mammaliferous strata of Nebraska and the adjacent regions bear full witness; and the South of France is said to have similar passage-beds between the Cretaceous and the Tertiary systems. Since then, that is, during the Tertiary period, and until now, continental areas, the nuclei of the present continents, have existed, with varying outlines and elevations, and with glaciers and river-systems, which have left numerous fresh-water formations. The Woolwich beds are the oldest of these. The London clay, lying on the last-mentioned, was the mud of a great gulf, receiving, perhaps, the same river, with others, draining a land rich with a sub-tropical flora of conifers, palm, spice-trees, etc., and stocked with crocodiles, serpents, birds, and mammals. A modification of the same drainage system afterwards washed the Palæothere and many other land animals into the seas and lakes of the subsequent period, as we see in the Barton Cliffs, in the Isle of Wight, and in the Paris district; for the Nummulitic sea came and went, and oscillations of the land changed the levels, and fresh water alternated with salt on many coasts. The middle Tertiary times had a still more chequered scene of sea and land; for bays, straits, archipelagos, rivers, lakes, and glaciers abounded. The Dinothere, Mastodon, and other land animals, great and small, and a characteristic flora, have been preserved here and there in lake-deposits of that time, often in beds of great extent and thickness.

In later Tertiary times the world had much the same continental contours as at present; but with vacillations, letting in the Glacial and Pluvial periods, when ice and water exerted their utmost power in modelling the northern hemisphere at least, and produced the great banks of gravel, and coatings of boulders and clay, that mask so much of its rocky surface. To the existing deltas, marshes, turbaries, lakes, glaciers, and river-systems, with their often subterranean streams, we need only refer as examples of the natural machinery by which fresh water acts in modifying the surface now, and has acted in times past, as shown by this brief sketch of the primæval rivers of Britain.

II.—ON *PALÆOCORYNE* A GENUS OF TUBULARINE HYDROZOA FROM THE CARBONIFEROUS FORMATION.

By P. M. DUNCAN, F.R.S., Sec. Geol. Soc., and H. M. Jenkins, F.G.S., Sec. Royal Agric. Soc.

(Phil. Trans. for 1869, pp. 693-699, pl. lxvi.)

THE remarkable little organism which forms the subject of this paper, was obtained from the lower shales of the Carboniferous limestone series of Ayrshire and Lanarkshire, so rich in fossil Brachiopoda, Polyzoa, Crinoidea, and Madreporaria; and was found attached to the margins of the polyzoarium of *Fenestellæ*, and also in a detached and more or less fragmentary condition amongst the small pieces of broken Polyzoa, and Crinoid stems which compose the fossiliferous layers of the shales.

The base of *Palæocoryne* was expanded, giving rise to a short robust and cylindrical stem fluted and punctated on its surface, and surmounted by the body of the polypito from the upper margin of which radiate a single whorl of long and slender tentacles. On the upper surface of the body, a crateriform process with an opening on its apex, indicates the position of the mouth.

Its external investment appears to have been calcareous, covering the whole of the hydrozoon, except at the opening for the mouth and the terminations of the tentacles which had probably ciliated ends projecting beyond the periderm or polypary.

This is an almost solitary instance of a Hydrozoon having a hard periderm, save the recent genus *Bimeria*, discovered on the West coast of Ireland by Dr. T. Strethill Wright.

The Zoological position of the fossil is amongst the Hydrozoa in the order Tubularidæ, and near the Eudendridæ. Two species are described and figured by the authors *Palæocoryne Scoticum* and *P. radiatum.*

III.—THE AMERICAN JOURNAL OF SCIENCE AND ARTS, VOLS. XLVIII. AND XLIX. Contains the following communications from Prof. O. C. MARSH, of Yale College.

I. *Notice of some new Mosasauroid Reptiles from the Greensand of New Jersey.*—A striking difference between the reptilian fauna of the Cretaceous of Europe and America, is the prevalence in the former of remains of *Ichthyosaurus* and *Plesiosaurus*, which in the latter appear to be entirely wanting; while the Mosasauroids, a group comparatively rare in the Old World, replace them in the New, being represented by several genera and numerous species. Recent explorations in the Cretaceous deposits of the Atlantic border, and in the region west of the Mississippi, have resulted in the discovery of many new forms of this peculiar type of reptilian life. Five forms are described by the author, namely:—

(1). *Mosasaurus princeps*, Marsh, sp. nov., perhaps the largest hitherto found, and when entire probably represented an animal not less than 75 feet in length. The remains are in excellent preservation, and include the greater portion of the skull with the maxillary teeth; one quadrate bone, one mandible, and about 26 vertebræ, besides several bones of the extremities.

(2). *Mosasaurus Copeanus*, Marsh, sp. nov. represented by portions of a skull, with some of the maxillary teeth, and part of the corresponding lower jaws, including the anterior extremity of the left ramus, etc. They indicate one of the smallest Mosasauroids yet discovered, and one very distinct from any hitherto known. These remains, Prof. Marsh considers, may indicate an animal about 25 feet in length.

(3). *Mosasaurus Meirsii*, Marsh, sp. nov. Indicated by the crown of a single tooth.

(4). *Baptosaurus* (*Halisaurus*) *platyspondylus*, Marsh. Founded on a posterior cervical and an anterior dorsal vertebra; the right splenial bone, and a small portion of the base of the skull, etc.; indicating an animal about 30 feet in length.

(5) *Halisaurus fraternus*, Marsh, sp. nov., established on an anterior and two posterior dorsal vertebræ. The vertebræ are more depressed than are those of *Macrosaurus lævis*, Owen, or *M. validus*, Cope, and indicate a smaller animal than either of these species, probably 25 or 30 feet in length.

Prof. Marsh next describes a new and gigantic fossil serpent (*Dinophis grandis*), from the Tertiary of New Jersey.

This species is founded upon a single dorsal vertebra, somewhat injured but having the neural arch well preserved. Two other fossil Ophidians have already been described by Prof. Cope, under the genus *Palæophis*, namely. *P. littoralis* and *P. halidanus*; these Prof. Marsh suggests should be included in the genus *Dinophis*, being very distinct from Prof. Owen's genus *Palæophis*.

II. *Notice of some Fossil Birds, from the Cretaceous and Tertiary Formations of the United States.* By Prof. O. C. Marsh, of Yale College.—The remains of Birds described from European rocks are at present limited in the Mesozoic to the famous *Archæopteryx* of the Jurassic, and a single species only from the Cretaceous: but in the Tertiary period, and especially in the Miocene and Pliocene, this class was very fully represented by many of the modern types, and numerous species have already been described by European Palæontologists. In America, however, since the discovery that the three-toed footprints in the Connecticut river sandstone were probably all made by Dinosaurian reptiles, no species of birds have been included in the extinct fauna, none having heretofore been described from any American rock. Recent explorations, however, have shown that remains of this class are not wanting in the later formations of the United States, and that the Cretaceous and Tertiary, especially, contain representatives of many interesting forms.

Remains of Cretaceous Birds.—Among the fossils under consideration are specimens indicating five species of Cretaceous birds, the remains of which were found in the Greensand of New Jersey, and, with a single exception, in the middle marl bed. The specimens are all mineralized, and in the same state of preservation as the bones of the extinct reptiles which occur with them in these deposits.

The remains described are as follows:—

(1). *Laornis Edvardsianus*, Marsh, gen. et sp. nov. Shaft and distal extremity of a left tibia, indicating a species apparently of a swimming-bird, nearly as large as the common wild swan.

(2). *Palæotringa littoralis*, Marsh, gen. et sp. nov.

(3). *Palæotringa vetus*, Marsh, sp. nov. Remains apparently of two wading birds; the former about the size of the European Curlew, the latter about as large as the Hudsonian Godwit.

(4). *Telmatornis priscus*, Marsh, gen. et sp. nov.

(5). *Telmatornis affinis*, Marsh, sp. nov. The remains of the former indicate a bird about the size of the King Rail, those of the latter of a bird considerably smaller.

Remains of Tertiary Birds.—The few remains of birds hitherto discovered in the Tertiary deposits of the United States, naturally show a much closer resemblance to recent species than those from the Cretaceous formation.

(1). *Puffinus Conradi*, Marsh, sp. nov. Discovered in the Miocene of Maryland, by T. A. Conrad, Esq.

(2). *Catarractes antiquus*, Marsh, sp. nov. Closely resembling the thick-billed Guillemot: found in Post-tertiary Clays, near Bangor, Maine.

(3). *Grus Haydeni*, Marsh, sp. nov. From the later Tertiary beds of the Niobrara river, indicates unmistakeably a large species of the genus *Grus* or Crane.

(4). *Graculus Idahensis*, Marsh, sp. nov. The species represented by this fossil appears to have been related to the Cormorants, and has been placed provisionally in the genus *Graculus*. This bird-bone was obtained from a freshwater Tertiary deposit, probably of Pliocene age, on Castle Creek, Idaho Territory, west of the Rocky Mountains.

In conclusion, Prof. Marsh mentions that he has just received from Prof. F. V. Hayden the distal portion of a feather with the shaft and vane, preserved from a freshwater Tertiary deposit of the Green River group, Wyoming Territory.

IV.—RECORDS OF THE GEOLOGICAL SURVEY OF INDIA.

Vol. III. Part 1. February. 1870.—(*Continued from p.* 341.)

THIS Part of the Records contains—in addition to Dr. Oldham's Annual Report noticed in our last number—p. 339,

2. *Notes on the Geology of the Neighbourhood of Madras.* By R. Bruce Foote, Esq.

The district under consideration lies to the north of the river Palar, and south of the Pulicat lake. The topographical features are simple: the ground rises from the coast westward in a gradually inclined plane, varied only by the shallow valleys of the Narnaveram, Cortelliar and Palar rivers, and in the south-eastern corner by a number of low hills. Roughly speaking, the northern, central, and south-western parts of this area are occupied by stratified rocks, the southern and south-eastern by metamorphic rocks. The following is a table of the rocks noticed in the neighbourhood:

Recent and Quaternary.	Blown sands. Alluvium, marine, and fluviatile. Laterite and Conjeveram gravels.
Tertiary.	Gritty sandstones. (? Cuddalore sandstones.)
Secondary.	(Cretaceous, not yet known in the area). Jurassic, Rajmahal plant-beds.
Sub-metamorphic.	Cuddapah group. (Quartzite rocks).
Metamorphic.	Gneissic series.

The *Laterite* deposits comprise clayey conglomerates, gravels, and sands, which graduate one into the other. They rarely attain a thickness of 12 feet. They are scattered over the higher grounds between the river valleys, and have evidently been separated by denudation into patches, some of small size, others attaining one and two hundred square miles in extent. The laterite gravels contain pebbles of quartzite and gneiss, mixed with pisiform ferruginous pellets.

The *Conjeveram gravels* occupy similar positions to the lateritic deposits, but they differ from these in the absence of ferruginous matter. Both appear to contain implements of human manufacture, in the shape of axes and spear-heads made of chipped quartzite pebbles, and of the same types as those which occur in the gravels of Western Europe.

The *Rajmahal beds* consist of conglomerates, sandstones, gritty clays, and shales. Numerous plant remains have been found in some of the clay beds, and particularly in a white shale. These remains include *Palæozamia*, *Dictyopteris*, *Taxodites* (?), *Pterophyllum*, *Tæniopteris* (?), *Stangerites*, *Pecopteris*, *Lycopodium* (?), and *Poacites*. Several genera of Mollusca have likewise been obtained from these beds; they include—besides several small Ammonites—*Leda*, *Yoldia*, *Tellina*, *Psammobia Lima*, *Pecten*, etc.

3. *On the Alluvial Deposits of the Irawádi, more particularly as contrasted with those of the Ganges.* By W. Theobald, Jun., Esq.

In every large river basin two distinct alluvial deposits will generally be met with. The older of these may be either marine (estuary) or fluviatile (lacustrine), or of a mixed and alternating character, but the newer group is essentially fluvio-lacustrine, and directly produced by the existing river. Whilst no very great thickness of the newer deposit can anywhere have been deposited without a corresponding subsidence of the area, a very large accumulation of the older or estuarine deposit may have taken place during an elevation of the area covered by it.

Every river that discharges its waters into the sea, does so under a condition either of subsidence, of quiescence, or of elevation, and to what extent this condition influences the character of the deposits as well as the physical peculiarities of the delta, Mr. Theobald endeavours to illustrate by the Irawádí, and the contrast which its delta presents to that of the Ganges.

These two—the Ganges and Irawádí—present examples of rivers subjected to, respectively, the first and last-named conditions. At Fort William boring operations for an artesian well showed 70 feet of the newer (Gangetic) alluvium, resting on the denuded surface of the kunker clay, which is indicated by the rolled kunker pebbles found at the junction. The author regards the kunker clay as an estuarine deposit (the older alluvium) accumulated during an upward movement of the land. It is a stiff clay, of a homogeneous character, and of a mottled yellow or pale buff colour, reddening by exposure. The kunker is disseminated through the clay, sometimes in well-defined nodules, more often in irregular stringy courses.

The newer alluvium comprises a very varied series of beds directly deposited by the waters of the Ganges or its tributaries. They consist of sand sometimes dark brown, at others a dazzling white, with several beds of peat. It is at once an extensive and important group deposited within the trough excavated by the Ganges in the older clay, or filling up such low-lying tracts as receive the flood-waters of the Ganges during its annual inundations. Mr. Theobald is of opinion that the area is undergoing depression at a rate which is adequately counterbalanced by the accession of Gangetic sediment on the surface.

Mr. Theobald then compares the alluvial deposits of the Ganges valley with those of the Irawádí, prefacing the subject with a few remarks on the physical character of the country, which presents some peculiar features.

The alluvium of the Irawádí belongs almost entirely to the older group, and the cause of this is attributed to the fact that the delta of this river is at the present time in precisely the same condition as was the delta of the Ganges when the first layers of its alluvium, 70 feet below the present surface at Calcutta, were being deposited. At this period the older marine group had become sufficiently raised to admit the deposition of beds stamped with a fluviatile and terrestrial character, and even the accumulation of such matters as peat; since then a steady downwater movement of the Gangetic delta has permitted the enormous accumulations of newer alluvium, which covers so large an area in Bengal. No such movement has hitherto taken place in the Irawádí area, and the proofs of a general elevation are sufficiently clear and undeniable. To a consideration of these Mr. Theobald devotes some space.

In conclusion, he points out the economic value of the two groups. It is on the newer alluvium that the finest indigo is grown, and indigo and silk (mulberry) may be said to be the two main staples of the Zillahs in Bengal. The newer alluvium will, moreover, he adds, produce any crop required of it, either rice, sugar, opium, oil seeds, etc., and hence the fertility for which Bengal is noted. In the Irawádí valley, in place of this fertile deposit, is the older alluvial clay, which though in some places it is capable of producing valuable crops of various descriptions, is generally fit to sustain nothing so well as rice crops; and hence the inability of the delta of the Irawádí to compare in richness with that of the Ganges.

REVIEWS.

I.—The Explorer's Test-Case; with the Key to Fortune in New Lands. S. W. Silver and Co., 66, and 67 Cornhill, E.C.

ONE of the great hindrances to the successful development of the natural productions of new countries, lies undoubtedly in the fact of the want of knowledge of the more simple means of recognizing the common, and therefore often the more important of the metals and minerals used so abundantly in the arts and manufactures. The settler's first thought is naturally to provide for his immediate necessities, and the cultivation of the soil becomes his first consideration. From day to day and year to year this work is carried on, and the mineral products around him, whether in the soil or the beds of neighbouring streams, or contiguous rocks, are unheeded; and even gold, a metal which it seems almost incredible should not be recognized at first sight, was overlooked for many years, both in California and Australia.

Writing on the "Gold-fields of Victoria" Mr. Brough Smyth says:—"Reefs of White Quartz, standing 20 feet above the surrounding surface, every foot of which contained gold, visible to the naked eye, excited neither curiosity nor inquiry; and the careless shepherd, whose earnings amounted to no more than 10*s.* or 15*s.* a week, every day drew water from the creek beneath whose bed lay nuggets and grains of gold, far exceeding in value the fee-simple of the run on which he was a labourer." (p. 4).

Not alone does this ignorance retard the search for minerals, but it also leads to ruinous blunders, which, whether perpetrated by individuals or by governments are equally to be regretted. Who will forget the unfortunate possessor of a beautiful stone said to be a diamond, who made a voyage to England from Australia for the purpose of disposing of it to better advantage—he having had already a considerable sum offered for it—only to find upon his arrival that it was a quartz crystal, value a few shillings. Or the story of the old copper kettle (no longer available to its owners at the Diggings for boiling water in on account of its leakiness) which one of the ingenious party industriously filed up into "gold-dust" and sold to a new-comer at a "ruinous sacrifice" just enabling himself and friends to "clear out."

The Explorer's Test-case has been designed with a view to prevent such mistakes, and to enable an ordinarily intelligent emigrant or traveller without any previous knowledge of mineralogy to ascertain, by a few characteristic and simple tests, the nature of the mineral products he may meet with, or be possibly surrounded by. It is not intended for the practical mineralogist or geologist, though doubtless to many of the latter it would be found to be an exceedingly useful travelling companion; but is adapted to guide the amateur and novice. The case and accompanying key are evidently designed by an experienced hand, one who has felt the want of such appliances whilst travelling in strange countries. It contains amongst other items, blowpipe, tools, and reagents, test-tubes, acids, ammonia, forceps, pliers, file, anvil, hammer, small balance with grain weights for finding specific gravity, materials for determining hardness, horse-shoe magnet, and pocket lens; and includes an explanatory key to the use of the whole. It is contained in a light, neat, but strong leather case and occupies only a small space (about the size of an ordinary octavo volume), a great recommendation to travellers of all classes.

We can have no hesitation in saying that with this test-case and key used intelligently, no settler need be without a fair knowledge of the minerals found on his property or within his district, and travellers would be able to tell us something more than they now do of the surface mineralogy of a new country, and save themselves the encumbrance of rock and mineral specimens which often turn out to be useless to themselves and every one else.

II.—The Mineralogist's Directory; or, a Guide to the Principal Mineral Localities in the United Kingdom of Great Britain and Ireland. By Townshend M. Hall, F.G.S. 8vo., pp. 168. London, 1868: E. Stanford.

THIS work is the first attempt to produce a list of all the minerals found at any given locality in the United Kingdom, and will be welcomed by all searchers after mineral specimens, whether professional or amateur. It is necessarily, to a very great extent, a compilation from lists published in the Transactions and Journals of various societies, papers in scientific periodicals, catalogues of museums, etc., involving an immense amount of labour, which only those who have endeavoured to ascertain the productions of one locality will appreciate. A list of the principal books used in this work will be found at the commencement of the volume. We are glad to find evidence of a careful scrutiny into some alleged localities for rare species, resulting sometimes in their exclusion.

Unlike its continental forerunners, the Mineralogical Lexicon for

.e Kingdom of Austria by Professor Zepharovich, and the Minerals ' Switzerland by Dr. A. Kenngott,—both of which include under each cality a description of the mode of occurrence, associated minerals, c., of each species,—this Directory is a simple statement of locali- s; and though there are many omissions and a few errors, it will obably be found by many to be nearly as useful a work for ritish, as the more elaborate Continental ones are for Swiss and ustrian localities.

With regard to the old Cornish term for a mine, *Huel*, the author ys, "Huel probably became corrupted first from its similarity of und with the Saxon *weal*, especially as mines were looked upon as fertile source of weal or wealth. This next became *wheal*, and so, ving lost its original signification, a double corruption has some- nes crept in, as Wheal Maria Mine, where the word 'mine' is thus peated twice." It is time that this error should be corrected, and cordingly Huel has been adopted throughout as the correct spelling; .e word still being in use in many parts of Brittany with the same eaning.

The introduction includes a table of the mineral species found in e British Isles, accompanied with the essential constituents of each d their amounts.

The mineral localities are grouped in the same county around eir respective post-towns, with the exception of those of Cornwall, hich, owing to the great number of mines, are referred to their spective parishes. In all cases where positively known, the forma- n is given, another point of interest in such a list.

Preceding an appendix, which includes a list of geological forma- ns with the minerals peculiar to or characteristic of their respective rata, is a list of localities of pseudomorphs, to which certainly umerous additions will have to be made.

Such a work as this has long been a desideratum, and Mr. Hall ay be congratulated on having succeeded so well in bringing his terogeneous and often contradictory materials into so intelligible shape.

We only hope that the author's request with regard to omissions errors will be liberally responded to by local collectors and hers, in order that the next edition, which is promised, may repre- nt more completely still the mineral productions of all British calities.

I.—THE LIFTED AND SUBSIDED ROCKS OF AMERICA, WITH THEIR INFLUENCE ON THE OCEANIC ATMOSPHERIC AND LAND-CURRENTS, AND THE DISTRIBUTION OF RACES. By GEO. CATLIN. London, 1860. 8vo. pp. 228. Trübner & Co, 8 and 60, Paternoster Row.

ATLIN, the hero of our boyhood, the historian of the North American Indians, comes before us here in a new character, a writer on physical geology, geography, and ethnography; and though we confess to a feeling of fond regret in not meeting with single buffalo-hunt, or a Pawnee chief in his war-paint in the book before us, it is a wonderful book nevertheless. No, Mr. Catlin has taken up the pen once more, not, however, to write on Indians, but on the great physical features of Northern and Central America, and to offer us his own opinions on the origin of mountains and valleys, rivers and seas, and the vast changes that have taken place in the relation of land and water since man, as civilized man, occupied Central America. Mr. Catlin, if not a profound scholar is, at least, a great traveller, and his observations therefore deserve our attention, even if we are unwilling to accept his theories.

The following is a brief statement of the leading topics, and the method in which they are dealt with by the author:—

1. Mountain chains have been uplifted by plutonic agency.
2. The uplifted mass has left a space beneath, equal to the mass originally elevated above the general surface-level of the ground. As all mountains have undergone a vast amount of subærial denudation and degradation, Mr. Catlin concludes that these submontagne caverns must be vastly larger in proportion than the present elevated rock-mass reared above them.
3. Mountain-ranges, such as the Rocky Mountains and the Andes, are vast rain and snow collecting areas.
4. The rivers which flow along the surface of the valleys at their feet, represent only a tithe of the waters falling upon their flanks, whilst of that which falls within their internal complicated area, or is condensed upon their snow-capped peaks, they receive none at all.
5. The greater part of the water falling upon these mountains descends at once by fissures into the submontagne caverns, and there collecting, flows as a vast river, maintaining its subterranean course down south to the Gulf of Mexico into which it debouches.
6. That from the 30th degree of south latitude, the waters of the Andes flow northwards, and the subterranean drainage no doubt resembles that of the Rocky Mountains.
7. That these two great submontagne rivers pour their waters by submarine outlets into the Caribean Sea and the Gulf of Mexico, from which they debouch as the Gulf Stream.
8. That there is evidence in the Mexican hieroglyphs, the inscriptions and monuments of Palenque, Copan, and Uxmal (translated by the Abbé Brasseur de Bourbourg, the last of which gives a complete translation of the "Teo Amoxtli," the Toltecan mythological history of the cataclysm of the Antilles), to prove that since the occupation of Central America by man, the vast area of the Caribean sea and the Gulf of Mexico, as far as the Antilles, has been submerged. (In a carefully prepared map which accompanies Mr. Catlin's work, he shows what he believes to have been the former extent, within the human period, of the Central American Continent.)
9. That the ruined cities of Yucatan and Guatemala with others of equal or greater extent, were sunk beneath the Ocean.
10. That the peninsulas of Yucatan and Guatemala, which were submerged in the general cataclysm, have risen again, revealing the ruins of the once splendid cities of Palenque and Uxmal—whose walls still bear evidence of their submersion in fragments of coral

ıd marine sand filling the niches and fractures of even the highest lifices and pyramids—whilst the still rising coast reveals other ıins traceable beneath its waters.

11. That the discoveries of Mr. Catlin himself, and of the Abbé rasseur de Bourbourg and others, prove that this region witnessed ıe birth and rise of the first civilization of the earth as well as the rst age of bronze weapons.

12. Writing on the distribution of Races Mr. Catlin regards the merican Indians—both North and South—as sprung from a comon stock created and placed within this central American region, ıd totally rejects the idea of an Asiatic immigration, claiming for ıe American races an origin as remote as that of any people in the orld.

Reverting to Mr. Catlin's geological views, it is of some interest notice that along the coast of Yucatan, vast quantities of freshater are poured from subterranean outlets into the sea. Between ıe open sea and this liquid mass a littoral bank is formed which ıns parallel to the coast for a distance of more than 170 miles, the ater on the inside being quite fresh, whilst that outside the bank salt.

Along the shores of the United States enormous volumes of fresh ater are constantly poured into the sea from subterranean rivers. he coasts between Nice and Genoa, those of Algeria, Istria, Dalatia, and even the shores of the Red Sea (destitute of subærial reams) have all their submarine rivers jetting up into the sea. or will anyone, familiar with the phenomena of mountains and vers, be disposed to object to the assertion of Mr. Catlin of the vast ıantity of subterranean channels in the Rocky Mountains into hich a very large proportion of the rainfall finds its way, probably ɔt to reappear until it is poured into the sea itself by some subarine vent. But it may be very reasonably doubted whether there any more connection between these fresh-water rivers, with subarine outlets, and the Gulf Stream, than between it and the waters ' the Amazons or the Mississippi itself. As to the temperature of ıe water we cannot agree with Mr. Catlin, that there is any ground r assuming that its subterranean course would bring it within the ınge of underground temperature sufficiently high to raise it into a ıat giving medium so effectually as by mere exposure to the rays of tropical sun, and we earnestly recommend to the author's conderation the careful calculations of Mr. James Croll upon this ıbject. GEOL. MAG. 1869, Vol. VI. p. 157. See also Vol. V. p. 301.

How far Mr. Catlin is able to prove his case for the recent formion of the Gulf of Mexico and the Caribean sea by the submergence ' this vast area in prehistoric time, and within the human period, ɪpears to rest mainly upon the acceptance and value, as historic ɾidence, of the translations of the Mexican inscriptions,[1] purporting to record these mighty events. We prefer, therefore, to leave these questions to the antiquary and ethnologist, who, as well as the geologists, will find in Mr. Catlin a shrewd and very original writer and observer,—fearless and severe in his criticisms, but giving abundant opportunity to those who please to do so to criticise him in return.

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[1] Some remarkable MSS. lately translated by the Abbé Brasseur de Bourbourg, e Codex Chimalpopoca and the Codex Troano, mention not only the existence a subterranean river under the Rocky Mountains, but also the destruction of e territory to the east of the present Republic of Mexico. These latter have,

REPORTS AND PROCEEDINGS.

Geological Society of London.—I. June 8th, 1870. Joseph Prestwich, Esq., F.R.S., President, in the Chair. 1. "On the Superficial Deposits of the South of Hampshire and the Isle of Wight." By Thomas Codrington, Esq., F.G.S.

This paper treated of the gravel deposits covering the Tertiary strata between Portsmouth and Poole, and of the Isle of Wight.

The strikingly tabular character of the surface is best seen on the east of the Avon, where from the coast for more than twenty miles inland a gravel-covered plain can be followed, rising gradually from 80 feet to 420 feet above the sea, at the rate of about 20 feet per mile. The high plains of the New Forest, to the eye perfectly level and indented by deep valleys, are portions of this table-land. The plateau between the Bournemouth Cliffs and the Valley of the Stour, and detached gravel-capped hills further inland, are the remnants of a similar table-land on the west of the Avon, while eastwards the same character prevails up to Southampton Water. Sections parallel with the coast show the level nature of the country, broken only by well-defined river-valleys. On the east of Southampton Water a similar tabular surface, sloping at a steeper angle towards the shore-line, and cut through by the valleys of the Itchen, Hamble, and Titchfield rivers, remains; and in the Isle of Wight the gravels capping the flat-topped Tertiary hills coincide with a corresponding plain sloping northwards.

The gravel covering these table-lands is composed chiefly of subangular chalk-flints, with a varying proportion of Tertiary pebbles. Sarsen stone blocks are found everywhere, and on Poole Heath granitic pebbles; and in the gravel of Portsea large boulders of granitic and palæozoic rocks are met with. In the Isle of Wight, chert from the Upper Greensand and materials from the Lower Cretaceous beds also occur. The colour of the gravel is generally red; and the origin of the white gravel, which often overlies the red, is to be ascribed to the bleaching action of vegetable matter. Brick-earth is generally associated with the gravel at all levels but the highest; but the contorted appearances attributed to glacial action only occur at low levels.

No organic remains have been found in the gravel covering the

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however, only recently been brought to light, and are not the sources whence Mr. Catlin obtained his information. Mr. L. Harper, Professor of Geology, U.S.A., in a letter to the Editor of the "Echo du Parlement," adduced a fact in confirmation of Mr. Catlin's theory, viz.: that a subterranean outlet of the Great Salt Lake has been discovered at Corinne, in the territory of Utah, U.S., which he thinks may largely contribute to the Gulf Stream.

plains, while the valley-gravels of the district have afforded mammalian bones and teeth of the usual species. Flint implements have been found at Bournemouth at 120 feet above the sea, at Lymington, near Southampton, at 80 and 150 feet, and also along the shore between Southampton Water and Gosport, at 35 feet above the sea, from gravel forming part of the covering of the tabular surface, and unconnected with the river-valleys.

The gravel capping the cliffs of the south coast of the Isle of Wight, in which the remains of *Elephas primigenius* have been found near Brook and Grange, was probably deposited in the same river-basin as the mammaliferous gravel of Freshwater; and the cutting back of the coast-line by the sea has given the tributaries of a river which flowed by Freshwater northwards to the Solent a direct outfall to the sea; and the streams thus intercepted at a high level, under the changed condition of flow, have originated the *Chines*.

The gravel cliff of the Foreland, at the eastern end of the Isle of Wight, consists principally of raised shingle, which towards the south thins out, and is overlain by a thick deposit of brick-earth, a continuation of which caps the cliffs up to the Chalk, and in which a flint implement was found by the author at 85 feet above the sea.

General Considerations.—The marine gravel, with granite boulders covering the south of Sussex, is continued westward by the gravel with similar boulders covering Portsea Island; and this again by the Hill-head gravels, with large blocks of Sarsen stone, these lower gravels being bordered on the south by the raised shingle deposits of the Isle of Wight, and on the north by the higher marine gravels of Avisford, Waterbeach, and Bourne, from which the lower gravel is divided by a well-marked step, extending beyond Portsdown Hill to Titchfield, and traceable on the west of Southampton Water. The Hill-head gravels are considered to be an estuarine deposit, of the same age as the marine gravels of Sussex, and the low level gravels of the river-valleys; they are supposed to have been formed when the Isle of Wight was still joined to the mainland, and all the rivers now reaching the sea by Poole Harbour, Christchurch Harbour, Southampton Water, etc., were affluents of a river communicating with an estuary opening to the sea in the direction of Spithead.

The gravels lying above the step, such as those of Avisford and Waterbeach, Titchfield Common, Beaulieu Heath, and Bournemouth, are looked upon as equivalent in position and age to the high-level valley gravels.

The level of the gravels on the highest parts of the table-lands is such as to indicate an age far greater than that of the highest gravels of the river-valleys; but the uniform surface from the 400-feet level downwards points to a long continuance of similar conditions, during which the gravel from the highest levels to that of the Bournemouth cliffs was deposited. The area that can with any probability be assigned to the catchment basin of a river such as that which has been before alluded to, is only three-quarters of the basin of the Thames above Hampton, within which it is difficult to imagine that such an extent of gravel could have been spread out; and the inclination of the flattest of the table-lands is for a river such as only mountain-streams have, and quite incompatible with the spreading out of large even surfaces more than twenty miles across.

It is considered more probable that the materials of the gravel were brought down from the chalk country on all sides by rivers, and spread out in an inlet of the sea shut in on the south, and opening out eastwards. This view is not without difficulties; it involves a gradual upheaval of the land, which, when the highest gravels now remaining were being spread out at or near the sea-level, must have stood more than 400 feet lower; and a considerable part of this upheaval must have taken place since the formation of the gravel in which implements fashioned by man are imbedded.

Discussion.—The President referred to the raised beach at Brighton, which he had traced thence as far as Chichester. He inquired what evidence there was of the marine origin and contemporaneity of the beds identified with this beach by Mr. Codrington.

Mr. Whitaker noticed the occurrence of gravels similar to those described by Mr. Codrington on the slope between Canterbury and Herne Bay, as indicative of the presence of a large river. He agreed with the author in considering that the white gravel was produced by the decolourization of the red: and remarked that it was unusual to find angular gravels of thoroughly marine type.

Mr. C. Moore remarked that the gravels and brick-earths from Salisbury westward are all of freshwater origin, and contain the remains of frogs in great abundance, together with freshwater shells, bones of *Arvicolæ*, etc.

Sir Charles Lyell was inclined to ascribe the formation of the gravels described to the sudden melting of snow in great quantities. He referred to the presence of Sarsen stones as indicating that there was force enough to carry large masses.

Prof. Ramsay referred to the great denudation of Eocene strata which must have taken place before the present form of the land was produced, as implying an immense amount of river-action, the immediate results of which are now masked by the modifications produced by subsequent sub-aërial changes of more limited extent. He maintained that the finding of flint implements at various elevations furnished no evidence of change in the relative level of sea and land.

Mr. Codrington, in reply, stated that the gravels were not valley-gravels such as those mentioned by Mr. Moore. He did not see how glacial action could have spread the gravels over flat table-lands.

2. "On the relative position of the Forest-bed and the Chillesford Clay in Norfolk and Suffolk, and on the real position of the Forest-bed." By the Rev. John Gunn, M.A., F.G.S.

The author commenced by stating that both at Easton Bavent and at Kessingland the Forest-bed is tó be seen forming part of the beach, or of the foot of the cliff, and underlying the Chillesford Clay. He considered that the soil of the Forest-bed had been deposited in an estuary, and that, after its elevation, the trees, of which the stools are now visible along the coast, grew upon it, and the true Forest-bed was formed. After the submergence of this, first freshwater, then fluvio-marine, and finally marine deposits, were formed upon it; and the author proposed to give the whole of these deposits the name of the "Forest-bed series." The author suggested that the Forest-bed itself is represented inland by the stony bed which lies immediately upon the chalk and between it and the Fluvio-marine and Marine Crags, his theory being that the surface of the Chalk, after supporting a Forest-bed Fauna, was gradually covered up by successive Crag deposits.

Discussion.—Sir Charles Lyell considered the Forest-bed to be older than the Stony-bed.

Mr. Gunn remarked that at Easton Bavent the Chillesford Clay is in the cliff, and the Forest-bed in the beach beneath it. He referred to various instances of the occurrence of mammalian remains on the coast.

3. "On a new Labyrinthodont Amphibian, from the Magnesian Limestone of Midderidge, Durham." By Albany Hancock, Esq., F.L.S., and Richard Howse, Esq. Communicated by Prof. Huxley, F.R.S., F.G.S.

The specimen described by the authors was remarkable for the great development of the ventral scutes, which were of large size, minutely striated, imbricated, and arranged in diagonal lines, sloping from behind forward, giving the surface of the fossil a strongly ribbed appearance. The authors stated that it was allied to *Dasyceps* and to *Pholiderpeton scutigerum* (Huxl.); but from the peculiar characters of its scutes, its elongated narrow muzzle, and some other peculiarities presented by the head, they regarded it as forming the type of a new genus, which they proposed to name *Lepidotosaurus*. The species they named *L. Duffii*, in honour of its discoverer, Mr. Joseph Duff.

4. "On *Proterosaurus Speneri* (von Meyer). and a new species, *Proterosaurus Huxleyi*, from the Marl-slate of Midderidge, Durham." By Albany Hancock, Esq., F.L.S., and Richard Howse, Esq. Communicated by Prof. Huxley, F.R.S., F.G.S.

In this paper the authors described a specimen which they referred to *Proterosaurus Speneri* (von Meyer); and one of smaller form, which they regarded as new, and described as *Proterosaurus Huxleyi*. Both were from the same part of the Marl-slate of Midderidge, Durham. The two species agree in having the limbs, tail, and neck long, and composed of seven vertebræ, in the number of dorsal vertebræ, in the number and character of the bones of the hand, and in some other particulars, sufficient, with these, in the opinion of the authors, to justify the reference of both to the genus *Proterosaurus*. In *P. Huxleyi* the ribs are flattened instead of rounded at the proximal extremity, and less widened and grooved at the distal extremity than in *P. Speneri*; the hind-limb is considerably longer in proportion to the fore-limb; and the distal extremity of the humerus is only twice as wide as the constricted part, instead of three times, as in the old species.

II. June 22nd, 1870.—1. "Notes on the Lower Portion of the Greenslates and Porphyries of the Lake District between Ulleswater and Keswick." By H. Alleyne Nicholson, M.D., D.Sc., M.A., F.R.S.E., F.G.S., Lecturer on Natural History in the Medical School of Edinburgh.

The author describes the characters presented by the lower part of that series of rocks, named, by Professor Sedgwick, the "Greenslates and Porphyries," which overlie the Skiddaw Slates in the Lake District. He notices the sections of this series in Borrowdale, on the east side of Derwentwater, between Keswick and the Vale of St. John, in the Vale of St. John, in Matterdale, in Eycott Hill, between Ulleswater and Haweswater, and in the neighbourhood of Shap. In the Borrowdale section the sequence of the rocks is given by the author as follows:—Resting on the Skiddaw slates there are (1) a felspathic trap; (2) a great series of ashes, breccias, and amygdaloids, often showing slaty cleavage and worked as slates, but with several intercalated bands of trap; and (3) a second trap. This appears to be a normal section, and is repeated, but diversified by the results of folding and faults in the other localities described by the author, except that in the Vale of St. John the true slaty series seems to be entirely wanting.

2. "Observations on some Vegetable Fossils from Victoria." By Dr. Ferdinand von Müller and R. Brough Smyth, Esq., F.G.S.

Mr. Smyth stated that the fossils, of which specimens were forwarded by him, were obtained in one of the deep leads at Haddon, near Smythesdale. No leaves have been obtained from the bed, which consists of a greyish-black clay; the fruits and seed-vessels were obtained about 180 feet from the surface, and represent a flora not very dissimilar to that now characterizing some parts of Queensland. The specimens sent include the fruits of a supposed new genus of Coniferæ, described by Dr. von Müller under the name of *Spondylostrobus.* It is most nearly allied to *Solenostrobus* (Bowerbank), but its five valves are not keeled. The columella forms the main body of the fruit; and the seeds are apparently solitary. The species was named *Spondylostrobus Smythii.* The remaining specimens consisted of a solitary fruit of a genus of Verbenaceæ; an indehiscent compressed fruit, probably belonging to the proteaceous genus *Helicia;* a nut nearly allied to the preceding; a large, spherical, unilocular, three-seeded nut with a thick pericarp, perhaps from a Capparideous plant; a five-valved capsule of an unknown genus; and fruit-valves of three other plants, probably belonging to the Sapindaceæ, and perhaps allied to *Cupania.* One of the last may belong to the Meliciaceous genus *Dysoxylon.* Dr. Müller considered that these remains indicate a former flora analogous to that of the existing forest-belt of Eastern Australia.

3. "Note on some Plesiosaurian Remains obtained by J. C. Mansell, Esq., F.G.S., in Kimmeridge Bay, Dorset." By J. W. Hulke. Esq., F.R.S., F.G.S.

The remains described in this Note represent two new species of *Plesiosaurus.* The dorsal vertebræ of the first species are distinguished by extremely short centra, with hollow articular faces. The antero-posterior diameter of four centra ranges between 1 and 1·3 inch, the transverse horizontal diameter between 4 and 4·6, and the vertical between 3·8 and 4 inches. For this Plesiosaur the author proposes the specific name of *P. brachistospondylus.*

The other species, of which the greater part of the spinal column and portions of the breast and pelvic girdles and limbs are preserved, is a long, slender-necked Plesiosaur, exceeding 16 feet in length. Its limbs are much larger in proportion to the whole length than in the typical Liassic forms of this genus; but what particularly distinguishes it from these are the massiveness of the humerus and femur, the longer size of the wing-like expansion of the postaxial border, a well-developed trochanter, and especially three articular facets at the distal end of the femur, corresponding to which the second segment of the paddle, representing the leg, contains three coequal bones. The author noticed the impression of a third bone in this segment in the matrix, in which a paddle of *Pliosaurus portlandicus* is imbedded, and the ossicle on the postaxial border of the fibula in *Plesiosaurus rugosus*. He compared the paddle-bones of the Kimmeridge *Plesiosaurus* with those of *Ichthyosauri* and of the Liassic Plesiosaurs and of *Pliosaurus*, he drew attention to the very close resemblance of the humerus and femur to type specimens of the femora of *Pliosaurus brachydeirus* and *P. trochanterius* in the British Museum, and traced a similar resemblance between the elements of the cnemion and tarsus, and those of the Dorchester and Portland Pliosaurian paddles. For this creature, combining a long truly Plesiosaurian neck with Pliosaurian-like limbs, the author proposed the name of *Plesiosaurus Manselii*.

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4. "Notes on the Geology of the Lofoten Islands." By T. G. Bonney, M.A., F.G.S., Tutor of St. John's College, Cambridge.

The author described the general appearance of the Lofoten islands, which have commonly been described as composed of granite, but which he stated really consisted of gneissic rocks. The scenery of some of the islands, on which he did not land, resembled that of the Cambrian and Cambro-Silurian districts of Wales and Cumberland; and the interior of Hassel showed dark rounded fells, resembling in outline some of the softer Welsh slates. At Stokmarknæs and at Melbo there is a granitoid rock of pinkish-grey colour, consisting of felspar and platy hornblende, with some mica and quartz. The Svolvaer Fjeld in Ost Vaagö shows a distinctly bedded structure in the cliffs near Svolvaer, the débris at the foot of which consist of a rock resembling syenite, and a quartzite containing a little hornblende and felspar. Bedding was also observed towards the Oxnæs Fjord. The islets near this coast consisted chiefly of a granitoid rock resembling a syenite, showing traces of bedding to the west of Svolvaer. Seams and veins of quartz, hornblende, etc., occurred in some of the islets, and these were sometimes too regular to be explained by deposition in fissures. Near the Svolvaer post-office there was gneiss coarsely foliated, containing hornblende and mica, with pink orthoclase felspar. The author concluded, from his observations, that, with few exceptions, the so-called granites of the Lofoten islands are stratified, highly metamorphosed rocks, quartzites, and gneiss, generally with much felspar in the latter, and with more or less hornblende in both, and that they are inferior in position to the gneiss and schists of the mainland, and to the more slaty rocks of the southern and western parts of the same islands. He compares them with some gneiss from Dalbeg on the west coast of the island of Lewis.

5. "On *Dorypterus Hofmanni*, (Germar), from the Marl-slate of Midderidge, Durham." By Albany Hancock, Esq., F.L.S, and Richard Howse, Esq. Communicated by Prof. Huxley, F.R.S., F.G.S.

The material for this paper consisted of four specimens of *Dorypterus Hofmanni*, which have been discovered by Joseph Duff, Esq., in the Marl-slate of Midderidge, and are believed to be the first examples of this fish which have been obtained in this country. The stratum from which they were procured is the same as that described by Prof. Sedgwick in his paper, published in the Transactions of this Society (2nd series, vol. iii., pp. 76, 77). The specimens show that the "ribbon-shaped" process mentioned by Germar is part of a peculiar exoskeleton, and that *Dorypterus* possessed ventral fins, which were situated in front of the pectorals, or "jugular." Hitherto, no fishes with ventral fins other than "abdominal" in position, have been known to occur earlier than the Cretaceous epoch. The tail is heterocercal, not homocercal, as Germar supposed. The dentition is not displayed in any of the specimens, and the teeth were probably small and inconspicuous; but the general structure of the fish shows it to be most nearly allied to the Pycnodonts.

6. "Observations on Ice-marks in Newfoundland." By Staff-Commander J. H. Kerr, R.N., F.R.G.S. Communicated by the Royal Geographical Society.

The author describes and tabulates the grooves and scratches observed by him on rock-surfaces in various parts of Newfoundland, especially Conception Bay, the neighbourhood of St. John's, and the north of Bonavista Bay. From the diversity of the direction of the markings and other considerations, he considers that they must have been produced by glaciers, and he believes that the main features of the country were much the same as at present, before the glaciation took place. The author thinks that the land has not been submerged since it was freed from its coating of ice.

7. "On the Glacial Phenomena of Western Lancashire and Cheshire." By C. E. De Rance, Esq., F.G.S.

The author described the general form of the ground and the preglacial condition and glacial deposits of the districts of Wirral and Western Lancashire, and draws from his observations the following general conclusions. That before and at the commencement of the glacial epoch the north-west of England was more elevated above the sea-level than at present, but afterwards gradually subsided, during which process marine denudation produced the plains of Wirral and Western Lancashire. Part of the latter has since been covered with glacial deposits 200 feet thick. The valleys running in the strike of the Triassic strata appear to have been formed by sub-aërial agencies. It is probable that when the glacial epoch commenced, the hilly country was covered with immense glaciers, or with an ice-sheet, which, as the land sunk, reached the sea. *The*

High-level lower boulder-clay was probably produced by this land-ice. The land continued subsiding until it stood 100 feet lower than at present, submerging the lowlands of Lancashire and Cheshire to a depth of rather less than 25 fathoms, the coast-line being surrounded by an ice-foot, which received on its surface quantities of pebbles and boulders from the lake-district. These, on the breaking up of the ice-foot, were spread over the lowlands, forming *the Low-level lower boulder-clay*. The climate then improved, although subsidence still continued, and the sandy and gravelly deposits of the middle drift were produced; these deposits, at whatever elevation they occur, having been found in shallow water during the constant subsidence of the coast-line. The surface of the middle Drift shows traces of what seems to have been sub-aërial erosion, leading to the supposition that the land must have risen and suffered denudation before that depression during which the Upper Boulder-clay was deposited, at which period the climate again became extremely cold, and fresh glaciers were formed. Before the elevation of the Upper Boulder-clay the climate was greatly ameliorated.

8. "On the Post-glacial Deposits of Western Lancashire and Cheshire[1]." By C. E. De Rance, Esq., F.G.S.

The author believed that after the deposition of the Esker Drift the country rose to from 200 to 300 feet higher than at present; but in the course of this elevation there was a pause, during which denudation took place, and the low plains, now covered with peat-moss, came into existence. From the consideration of the present depths of the channel between Great Britain and Ireland, the author inferred that an elevation of 200 feet would have caused the coast-line to run from the Mull of Galloway to St. David's Head; and Ireland would have been so connected with Wales as to render possible the migration of mammals, plants, and of man himself. Glaciers probably still persisted in the lake-district during the whole of this period of elevation. During a subsequent subsidence drainage became greatly obstructed, peat was formed, the sea encroached upon the land and worked its way eastward over the sea-bottom of post-glacial times, a movement yet in progress. Here and there sand has begun to blow, forming dunes.

9. "Observations on Modern Glacial Action in Canada." By the Rev. W. Bleasdell, M.A., Rector of Trenton. Communicated by Principal Dawson, F.R.S., F.G.S.

The author described some phenomena of ice-transport observed in Canada, especially those produced by the flood, anchor or pack-ice produced in the rapids of the Canadian rivers. To this he attributed the entire disappearance of Crab Island in the River St. Lawrence, near Cornwall. This island occupied about an acre and a half within the memory of men now living; it has now entirely disappeared, and the water above it is gradually deepening. The island, according to the author, has been carried away piecemeal by the action of miniature icebergs, floated off by a rise in the water produced by a dam of anchor-ice below.

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[1] An error occurred in the title of this paper as printed in the Society's abstract, namely, "*Pre*-glacial" instead of "*Post*-Glacial.—Ed.

10. "On an altered Clay-bed and Sections in Tideswell Dale, Derbyshire." By the Rev. J. M. Mello, M.A., F.G.S.

The author describes the sequence of the rocks seen in a quarry in Tideswell Dale as follows:—Beneath a thin layer of surface-soil is a bed of Toadstone, containing concretionary balls, and much decomposed above; beneath this is Toadstone in large blocks of indefinite shape, very hard, dark green, and apparently doleritic, nine or ten feet thick, passing downwards into a coarse and much decomposed bed, partly amygdaloid, partly vesicular, about one foot thick. Beneath the Toadstone rocks, and without any sharp line of demarcation, is a thick bed of indurated red clay, three yards in thickness, presenting a regularly prismatic-columnar structure, resting on a thin bed of greenish-yellow clay, containing fragments of limestone, which covers beds of good Derbyshire marbles containing corals. The author suggests that the columnar clay-bed may perhaps be a local development of that which forms partings in the limestone near Litton Tunnel.

(*To be Concluded in our next Number.*)

CORRESPONDENCE.

MR. DAVID FORBES, F.R.S., ON RAIN AND RIVERS.

SIR,—In the GEOLOGICAL MAGAZINE for this month, p. 314, is a paper, entitled "D. Forbes on Volcanos," being the substance of a lecture delivered in St. George's Hall, 19th June, 1870. The object of the lecture is to show that subterranean heat has, and ever has had, as much to do with the formation of the surface of the earth as rain and rivers have. Mr. Forbes seems to put this doctrine forward as an originality of his own, and as if it was foreign to the rain and river theory. It is, however, part and parcel of that theory. Mr. Forbes, p. 327, says, "British geologists of late years, all but ignoring the action of internal forces, have striven to account for everything in the shape of external configuration or scenery by the action of water in its different forms of rain, rivers, the sea, or ice;" and again, "In answering the question, therefore, as to which of these forces" (internal fire or external water) "has played the most prominent part in determining the external configuration of the earth, the unbiassed geologist must necessarily grant the first rank to the internal volcanic or cataclysmic agencies, since had it not been for their operations our globe would still have remained a comparatively smooth sphere, surrounded with its external envelope of water, with no visible land for the rivers to traverse or the rain and ice to disintegrate and wear away; in fact, it was only after the internal agencies had produced their effects that the external forces were called into play, and then became the great agents in modifying the outlines of our earth to their fullest extent."

If Mr. Forbes will only read the book entitled "Rain and *Rivers*," he will find his idea stated there over and over again.

The 13th chapter is headed "Fire *forms* continents, **water** ***transforms*** them." In page 165 is a sentence headed "It is only *fire* which keeps our heads above *water*. It is only owing to subterranean igneous action that the solids of the globe are not submerged below shall I say 3,000 feet of water." In page 111 is this passage in reference to Madeira and Teneriffe, "These islands exemplify the *contrary* effects of the contrary causes—fire and water, and vividly pourtray the perpetual contest between the two powers. They show us that rain, which we consider only as a productive power, is the destroyer, the dissolver of continents, and that subterranean igneous action, which we consider as a destructive power, is the producer, the replacer of continents." In page 184 is this passage: "Subterranean igneous heat is the quarryman who raises the block. Rain is the artist who shapes its surface. We owe the beauty of the surface of the earth to water, not to fire. Could the labourer of Paros with justice write, *non me Praxiteles fecit*, on some divine production of the artist? Did Baily form his exquisite Eve or the workman of the Carrara quarries?" In page 138 a paragraph is headed "Mountains while rising may be decreasing in height." Suppose the Alps to have been rising six inches in a century for myriads of years, if their denudation has been seven inches they have been decreasing in height.

Mr. Forbes is mistaken in supposing that "the old leaven remains" of the dispute between the Neptunists and Vulcanists or that it had anything to do with the formation of the surface of the earth. The question was simply whether certain trap rocks were formed by fire or were precipitates from water, which question was settled long ago.

I am, however, glad that while Mr. Forbes thinks that he differs from "Rain and Rivers," because he has not read it, he, in fact, agrees with the book entirely; and the doctrines of his lecture are the doctrines of "Rain and Rivers." I am also glad that in the paper which precedes Mr. Forbes's, my friend Mr. Kinahan, attributes so much to *Meteoric abrasion*. But I wish that he would change this (as Humboldt would say) "exalted form of speech," for the more humble title of Rain and Rivers.

George Greenwood, Colonel.

Brookwood Park, Alresford, 3*rd July*, 1870.

MISCELLANEOUS.

Congress of Alpine Geologists at Geneva.—A meeting of Geologists interested in the Alps, under the presidency of Professor F. J. Pictet, with Professor Favre for Vice-President, and MM. E. Favre and E. Sarasin as Secretaries is convened for the 31st August and 1st and 2nd September. The aim of the meeting was to assemble together at Geneva, the savants of the two sides of the Alps, and of the eastern and western extremities of the chain, in order to unite the French, German, and Italian men of science in closer intimacy. The same invitation is also addressed to English Geologists. Alas! there is reason to fear that many of those who would have been present, will be detained either by the sad calamity of war in which their respective countries are involved, or by a disinclination to travel during its continuance. To those who are not so hindered, the prospect is an inviting one—not only to be present at the reading and discussing of some able papers upon the Alps—but also to accompany some of the best Swiss and other Alpine Geologists to the spots of greatest geological interest and study their rock-features together. We heartily wish the Congress the success it so well merits, but cannot be otherwise than apprehensive that the present state of Europe is inimical to it.

PRESENTATION OF A TESTIMONIAL TO PROFESSOR JOHN MORRIS, F.G.S., ETC., OF UNIVERSITY COLLEGE, LONDON.—It will be in the recollection of most of our readers that a subscription list was opened last Autumn for the purpose of presenting a substantial testimonial to Professor Morris, in recognition of the important services he has rendered to Geological Science, not only by his lectures and publicatious, but also by the readiness he has at all times displayed in imparting information to others out of the rich store of knowledge which he possesses, whether in geology, palæontology, or mineralogy. To carry out this object, Sir Roderick J. Murchison, Bart., K.C.B., consented to act as President; Mr. William Milnes, as Treasurer; and Mr. Edward D. Hearn, as Secretary. Upwards of £600 having been subscribed, a meeting was convened on the 14th July, at the apartments of the Geological Society, Somerset House, Sir Roderick Murchison, Bart., being in the chair, supported by the President of the Geological Society, J. Prestwich, Esq., F.R.S., the Treasurer and Secretary, and a numerous assemblage of Mr. Morris's friends. An address (the wording of which had been entrusted to Professor Phillips, F.R.S., of Oxford), beautifully engrossed and illuminated on vellum, and framed in a suitable manner, was presented to Prof. John Morris by Sir R. Murchison, together with the proceeds of the subscription, and the Silurian chieftain made a most admirable speech, in which he was followed by Mr. Prestwich, both these gentlemen being among Prof. Morris's earliest and most attached friends. In returning thanks, Mr. Morris (who was most heartily cheered) made a most touching and eloquent speech, in which he referred to his early Geological labours and travels, nearly thirty years ago, in the company of Murchison and Prestwich. Mr. Prestwich afterwards read a letter just received by Mr. Hearn, the Secretary, from the venerable Prof. Sedgwick, expressing his regret that the infirmity of years prevented his being present, but assuring Mr. Morris of the cordial esteem and regard which he entertained for him and for his scientific labours. The usual vote of thanks to the President, Treasurer, and Secretary of the Morris Testimonial Fund, terminated the proceedings.

THE
GEOLOGICAL MAGAZINE.

No. LXXV.—SEPTEMBER, 1870.

ORIGINAL ARTICLES.

I.—ON A NEW *CEPHALASPIS* DISCOVERED IN AMERICA, ETC.

By E. RAY LANKESTER, B.A., Coutts Geological Scholar, Oxford.

PRINCIPAL Dawson, of Montreal, Canada, has placed in my hands for description a remarkably interesting specimen, indicating a species of the genus *Cephalaspis* in transatlantic Silurio-Devonian beds. He writes, "The specimen was found by one of my assistants, Mr. G. F. Kennedy, B.A., when collecting with me, in a bed charged with remains of *Psilophyton*, on the north side of Gaspé Bay. The geological horizon is below the middle of the Gaspé Sandstones, but several hundreds of feet above their actual base, so that the specimen may be regarded as either Lower Devonian or Lower Middle Devonian. It occurred in beds containing *Psilophyton princeps* and *P. robustus*, and also drift-trunks of *Prototaxites Logani*, the latter in the sandstones associated with the coarse shaly bed containing the *Cephalaspis*. In these sandstones there are also spines of *Machairacanthus sulcatus* of Newberry—a large fish characteristic of the Devonian of Ohio. No marine remains were found in the bed holding the *Cephalaspis*,

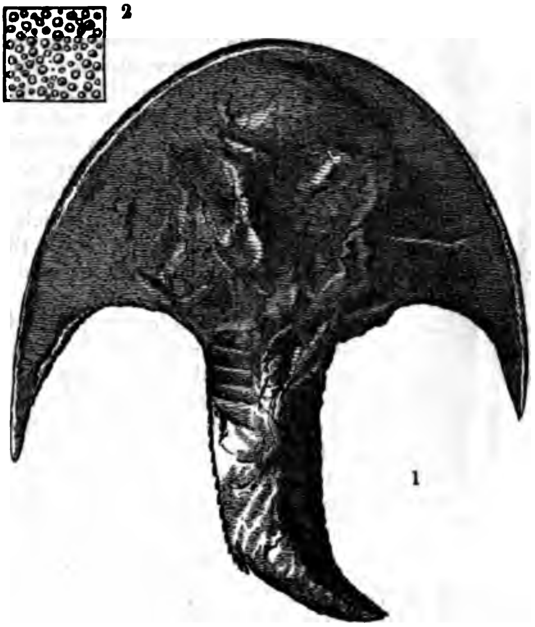


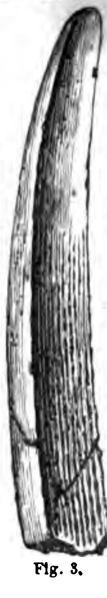
Fig. 1. *Cephalaspis Dawsoni*, Lankr. (nat. size).
Fig. 2. Part of surface magnified.

which is blackened with vegetable matter and holds many fragments of land plants; but in shales at no great vertical distance there are shells of *Lingula* and *Modiomorpha*, resembling species found in the Hamilton group of New York."

The specimen (Fig. 1) presents in slight relief a small *Cephalaspis*, with head-shield and greater part of the body, and is much flattened. The shield appears to be larger in proportion to the body than in any British species. The orbits are not shown, and the matrix has not preserved the scales of the body with much distinctness, though it is possible to make out the lateral and marginal series. No trace of pectoral, dorsal, nor caudal fins is to be made out. This species clearly belongs to the section *Eu-cephalaspis* as defined in my Monograph of *Cephalaspidæ*.[1] Its best character as a species is to be found in the very fine, almost granular, tubercles (Fig. 2) which are preserved on some parts of the surface, and represent the apparently universally present tubercular ornament of the *Osteostraci*. These fine tubercles are more minute than on any British *Cephalaspid*, and, though seemingly not very well shown in this specimen, furnish a specific mark. Amongst other fragments from this bed, which Dr. Dawson has submitted to me, is a small piece of tubercle ornament, possibly belonging to the same species of *Cephalaspis*. In this, the tubercles are very sharply moulded and nearly hemispherical. Various other fragments which cannot be identified, but are probably bits of fish bones, etc., are amongst the collection.

A very fine fish-spine—the *Machairacanthus sulcatus*—is drawn at Fig. 3 from a specimen which was also obtained in the sand-stones associated with the shale which furnished the *Cephalaspis*. This sandstone is not unlike the sandstone of Glamis, and other parts of Perthshire and Forfarshire which furnish *Cephalaspis*; whilst the shale strongly recalls the Forfarshire shale, which has furnished Mr. Powrie with his beautiful *Cephalaspis Pagei*.

The spines which occur in the Cornstones of Herefordshire, which have not yet been worked out, are of various forms and are usually "lumped" as *Onchus*. None, however, appear to resemble *Machairacanthus*, with its remarkable keeling like the petiole of a sweet-pea. I propose to call the new American *Cephalaspis* after the illustrious geologist who has allowed it to be figured here: *Cephalaspis Dawsoni*.



Machairacanthus sulcatus (nat. size).

Fig. 3.

Note on *Scaphaspis Knerii*.

When at Vienna in the spring I was very anxious to see Dr. Kner's original type of the genus *Pteraspis*, and was enabled to do so through the kindness of Professor Reuss, who after some hunting

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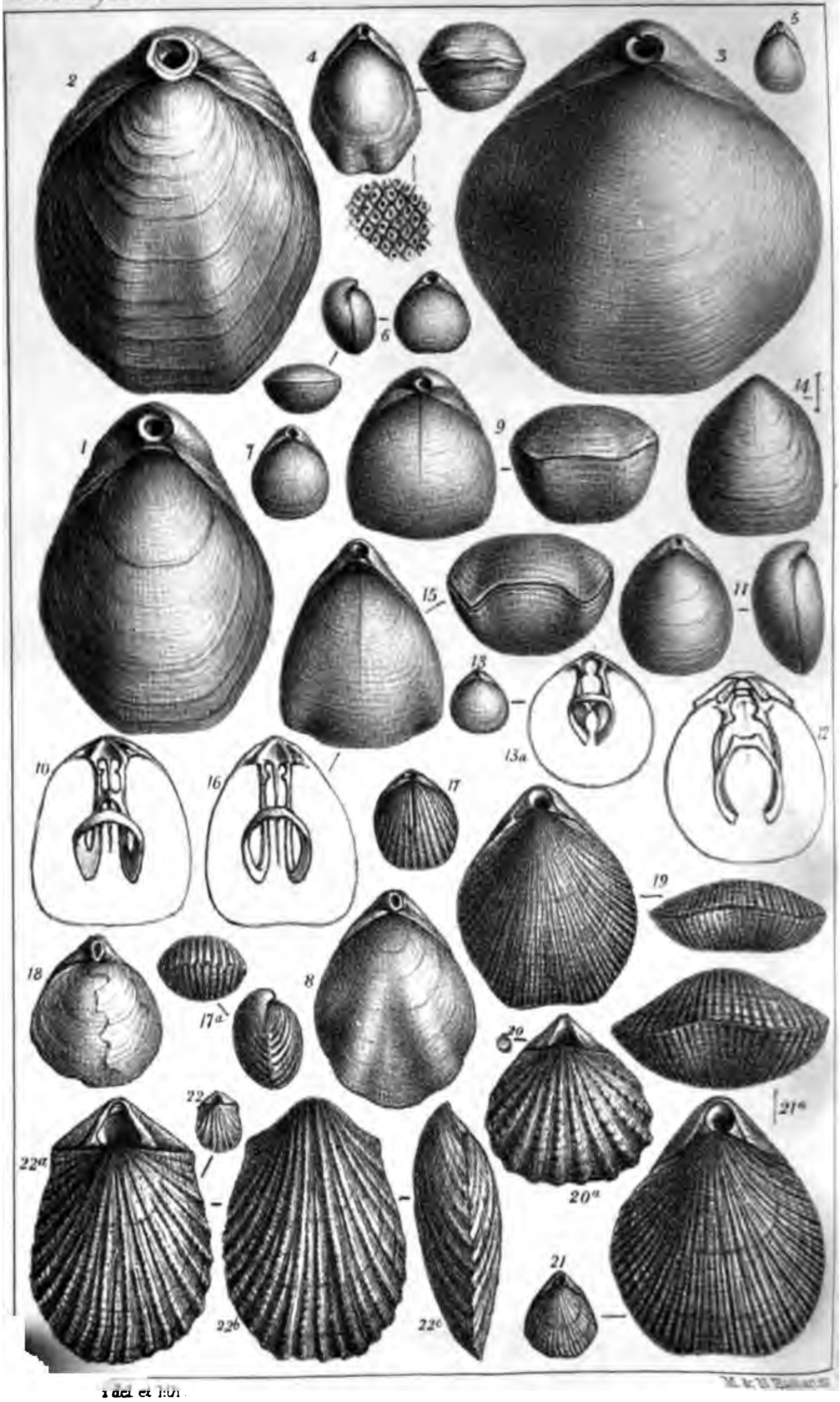
[1] Monograph of the Fishes of the Old Red Sandstone of Britain by J. Powrie, F.G.S., and E. Ray Lankester. Part I. The *Cephalaspidæ*, by E. Ray Lankester Mon. Pal. Soc. 1868, p. 20, fig. 9.



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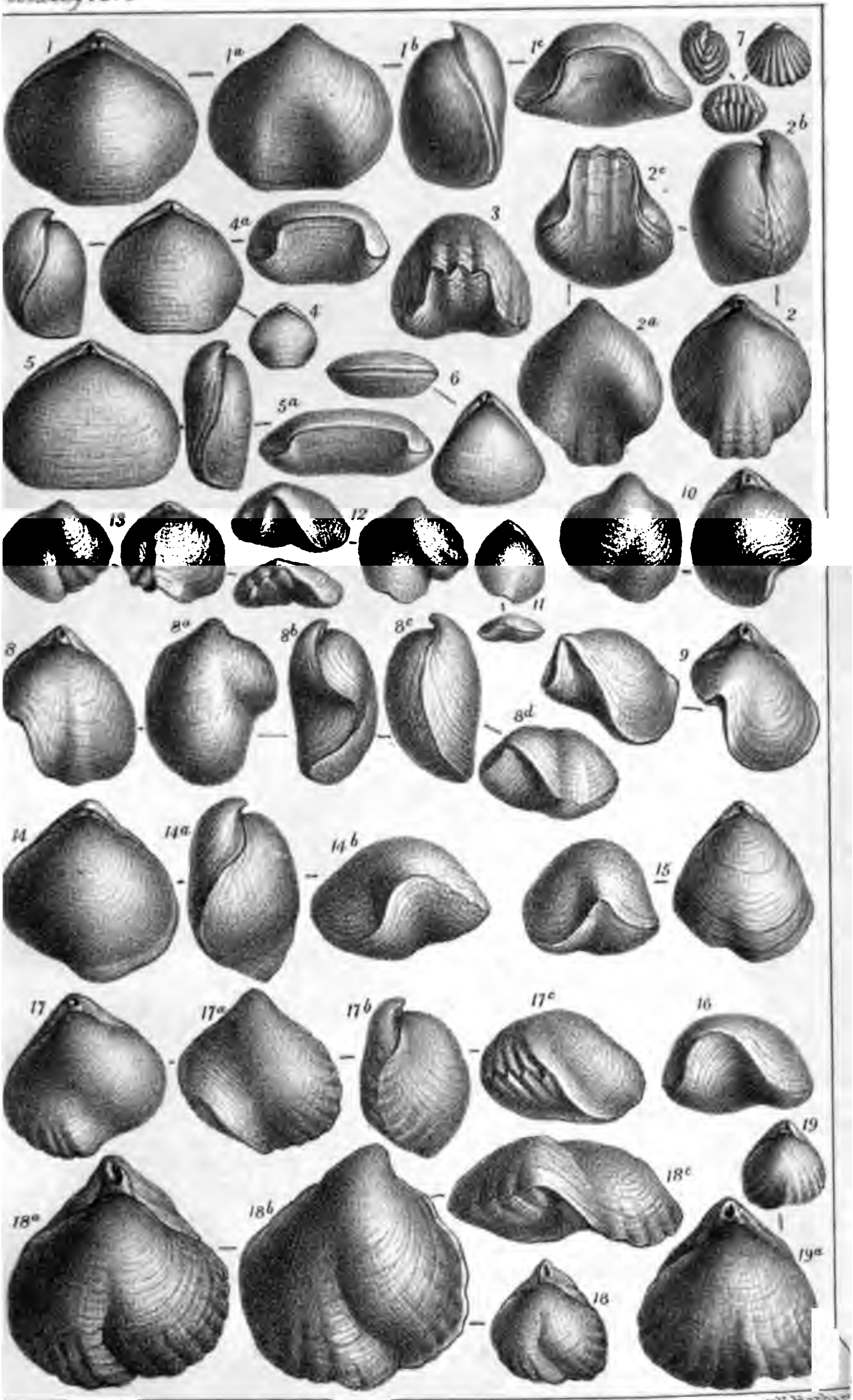
ITALIAN TERTIARY BRACHIOPODA.



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ITALIAN TERTIARY BRACHIOPODA.

(Dr. Kner having lately died) came upon the specimens. They had been in the Museum twenty years before Kner described them; the exact locality from which they came is Zaleszczyk, on the Dneister, upon the borders of Russia and Galicia; a very inaccessible place and one of which the geology appears to be very little known, excepting that there are both true Upper Silurian and true Lower Devonian beds there, with complete transition. An odd specimen was with the three bits from Zaleszczyk, which had not come with them and seemed to me to be undoubtedly from Herefordshire. The resemblance, however, of the rock in which the Galician specimens were embedded to our cornstones was striking; the figured specimen was in matrix having a little more of a limestone character. Kner's figure, of which a woodcut copy is given in the Monograph of *Cephalaspidæ*, is bad and misleading.[1] The specimen is much more like *Scaphaspis Lloydii* than is the figure, the central ridge not being marked at all as I had thought from the drawing. In fact, the resemblance to *Sc. Lloydii* is exceedingly close, the posterior corners of the shield, however, in the Galician species being somewhat produced, instead of quite rounded off, as in *Sc. Lloydii*.

Two interesting things were noticed in the specimens. Firstly, that a form like *Pteraspis rostratus* is also present in one of the blocks; and, secondly, that in the block with Kner's figured specimen there are *marine* shells. An *Orthoceras* is lying almost against the fish-shield, which is very perfect, and there are two *Lamellibranchs* in close proximity. We must not therefore conclude from the corn-stones and Scotch beds that the *Cephalaspidæ* were exclusively lacustrine or fluviatile. The Galician specimen is tolerably perfect and has not been much knocked about by sea waves, as the Steganodictyan fish-remains of Cornwall and Devon seem to have been before deposition.—E.R.L.

II.—ON ITALIAN TERTIARY BRACHIOPODA.

By THOMAS DAVIDSON, F.R.S., F.G.S., ETC.

(Plates XIX. and XX.)

Continued from p. 370.

23. *Terebratula Voglianei* (Michelotti), Pl. XIX. Fig. 18. Essai sur le Miocène Inf. de l'Italie Sept. p. 51, Pl. 4, Fig. 15, 16, 1861; and Sequenza, Brach. Mioc. delle Provincie Piedmontesi, 1866.

NO very perfect example of this species appears to have been collected; the one figured in my plate was kindly given to me by Sig. Meneghini. The shell is ovate and smooth, about ten lines in length by nine in breadth; the valves are moderately convex, and there exists a deepish sinus in the ventral valve to which corresponds an elevation or fold in the opposite one. *Ter. Voglianei* occurs in a yellowish marl in the Lower Miocene at Dego, and along with it is found a small *Terebratulina*, which may probably be a variety of *T. caput-serpentis*.

I would beg leave to suggest that Italian Palæontologists should seek for better examples of this species, as well as of the so-termed *T. miocenica* and *T. anceps*, in order that their specific claims may be accurately determined.

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[1] See Note, preceding page.

Sig. Sequenza is now of opinion that his *T. Lyelliana* is a synonym of *T. minor*, and that his *T. Benoitiana* will require to be added to the synonyms of *T. sphenoidea.*

24. *Terebratula rhomboidea* (Biondi), Pl. XIX., Fig. 8. Memoria prima su alcune specie Malacologiche Siciliane. Atti dell' Accademia Gioenia di Scienze Naturali di Catania, second series, vol. x., p. 8, pl. iii., figs. 2 and 3, 1855.

I have never seen a specimen of this species, and consequently cannot discuss its specific claims. I have reproduced one of Sig. Biondi's figures. The shell is ovate, smooth, and biplicated; about fourteen lines in length by ten in width, and was found by Sig. Biondi at Cape Pachino, in Sicily, and in beds that have been referred to the Eocene period.

25. *Terebratula caput-serpentis* (Linné), Pl. XIX., Fig. 19.

Out of mere variations in shape and age of this variable shell, many so-termed distinct species have been fabricated; but the makers of these species have generally failed in establishing any really distinctive characters. After a lengthened examination of a number of specimens, I am almost disposed to believe that *T. caput-serpentis* has continued to exist throughout the entire Tertiary period, and it is now a common shell in many seas. It is even probable that its ancestors lived during the Cretaceous period. Anyhow it occurs in the Lower Miocene at Dego; in the Middle Miocene at Grangia and Gassino, in the Hills of Turin; in the Upper Miocene at Starzano (Tortonese); Marmorito (Province of Asti), etc., in Tuscany. It abounds in the older and newer Pliocene of various parts of Italy; in Calabria, Sicily, etc. It is common also in the Quaternary deposits of the same kingdom, in the south of France, at Nice, Gibraltar, etc. Some Italian Eocene specimens, as well as some from Biarritz, seem to me undistinguishable from *T. caput-serpentis.*

26. *Terebratulina Taurinensis* (Sequenza), Pl. XIX., Fig. 20, 20*a*. Piedmontese Brachiopoda, annali dell' Accademia degli aspiranti di Napoli, third series, vol. vi., pl. iii, figs. 1, 1*a*, 1866.

I have seen only one example of this minute shell, and cannot consequently discuss its specific claims. It may very possibly be no more than a young stage of *T. caput-serpentis.* Sig. Sequenza figured a dorsal valve only, but since then Sig. Rovasenda has found a complete specimen, which I have figured in my plate. It occurs in the Middle Miocene of Gassino, a locality at three hours distance from Turin.

27. *Terebratulina striatula* (Sow. ?) Pl. XIX., Fig. 21, 21*a*.

Many of the specimens obtained by Sig. Meneghini and M. Bayan from the Eocene beds in the north of Italy can scarcely be distinguished from some of our English examples of *T. striatula.* It is variable in shape, some specimens being shorter and broader than others. The dorsal valve is usually uniformly convex, but a slight median depression towards the front is also sometimes present in specimens of this species. The surface is ornamented by numerous radiating ribs, with interspaces between them of about equal breadth. In these interspaces are interpolated one or two shorter ribs, the entire surface being crossed at intervals by concentric lines of growth. This shell has been confounded by Baron Schauroth and others with the *Terebratulina tenuistriata* of Leymerie, but in this last named shell the ribs are much finer and more numerous than in the species under description. *T. striatula* (if I am correct in my identification) was found by Sig. Meneghini, at Breonio, and by Mr. Bayan, in his Eocene stages, E. and F., at the Bucca di Scissa and Val di Scaranto, near Brendola (Colli Berici); Castellunga near Castelcies; Lonigo, and Val di Lonte in the Vicentin; Valle Organa near Bassano; as well as in his Oligocene, stage G., at San Gonini Lugo.

28. *Terebratulina ? Michelottina* (Dav.), Pl. XIX., Fig. 22, 22*a*.

Shell small, oval, compressed, longer than wide, broadest anteriorly, sides and front rounded; hinge-line straight, a little less than the width of the shell; beak prominent, area flat, fissure large and laterally margined by prominent deltidial plates; dorsal valve semicircular, elongated, with acute cardinal extremities, very slightly convex; surface of valves ornamented with from 22 to 24 radiating rounded ribs, of which half that number commence at variable distances from the beaks and extend to the front, so that a smaller or shorter rib intervenes between each pair of the larger ones. The shell is largely punctured; interior not known; length 4, width 3, depth 1 line.

Mr. Bayan collected three or four examples of this pretty little shell in the Eocene, stage E., at Mossano (Colli Berici) near Vicenza. It is remarkable on account of its flattened appearance, as well as from the length of its hinge-line.

29. *Terebratula* (or *Waldheimia ?*) *Hilarionis* (Meneghini M.S.) Pl. XVII. Fig. 4, 5. *Terebratula Hilarionis* (Meneg.) Bayan, Bull; Soc. Géol. de France, second series, vol. xxvii., p. 459. 1870.

Shell variable in shape, nearly circular, a little longer than wide, broadest posteriorly, tapering gradually towards the front which is more or less regularly rounded. Dorsal valve either moderately and uniformly convex or with a slight median depression in the anterior half of the valve. Ventral valve convex and slightly deeper than the opposite one; beak small, rounded, and much incurved—laterally compressed and keeled along the middle; beak ridges sharply defined, foramen minute; surface of valves smooth; length 15, breadth 14, depth 8 lines.

The identification of this shell has given me some trouble, and I am still uncertain whether it might not be referable to a species already named. It bears a striking likeness to some forms of Liassic *Waldheimia numismalis*, and it is possibly the shell alluded to by D'Archiac in the third volume (p. 276, 1850) of his "Histoire des Progrés de la Géologie," under the designation of *T. subnumismalis ;* this species being stated to occur in the Eocene beds of the Kressenberg, but as the Viscount neither describes nor illustrates his species his name cannot supersede the same designation given by myself to a well known Liassic species. It may likewise perhaps be referable to one of the species from the same locality described by Schafhäult in his work on the Kressenberg (1863), such as perhaps to his *T. picta*, but if so, that designation had been previously assigned to a recent species, and consequently could not be retained for the shell under description. It is also, I think, the same species as the one, perhaps incorrectly, identified by Ooster in his work on the "Brachiopodes fossiles des Alpes Suisses" (pl. ix. 1863), under the designation of *Terebratula Kickxii*, Galeotti; but Dr. L. de Koninck, to whom I sent drawings of our Italian species, assures me that it is specifically distinct from the one described by Galeotti in his memoir "Sur la constitution Géognostique du Brabant," pl. 4, fig. 15, 1837, which was subsequently better figured by Nyst in his work "Sur les coquilles et Polypiers de Belgique," pl. 29, fig. 4. When adult, *T. Kickxii* and its synonyms *T. trilobata* and *T. lævis* are elongated shells, wide near the beaks, and tapering considerably towards the front; *T. Kickxii* occurs in the sands of Assche and Gand, and also in the Eocene sands of Cassel, near Dunkirk. The interior of our Italian fossil is not known. Sig. Meneghini procured his specimens from the volcanic tuffa, or Lower Eocene of St. Giovanni Ilarione, in the Vicentin territory[1] and he gave to it the manuscript designation of *T. Illarionis*, but as Mr. Bayan has spelt the name with an *H*, in his published memoir, it will be preferable to leave it so in this communication. The shell was found by Mr Bayan in his Eocene stages B. and C., along with *Nerita Schmiedeli* at the Val di Ciampo, Croce Grande, Pozza; also at La Gichelina, near Malo, etc. This rock, which in some places assumes the form of a friable green sand, would correspond to the horizon of the *Calcaire grossier* of the Paris basin (lower part), for it contains such shells as *Terebellum sopitum, Strombus Bartonensis*, and other such species of that epoch.

30. *Waldheimia septigera* (Loren), Pl. XIX., Fig. 15, 16. *Ter. septigera* Loven; Moll. Scand., p. 29, 1846; and for figure Dav. Annals and Mag. of Nat. Hist., second series, vol. 16, pl. x., fig. 1. *Waldheimia peloritana,* Sequenza, Sicilian Brach, pl. vi., fig. 1–10. 1865.

Sicilian Lower Pliocene, specimens of this shell were described by Sig. Sequenza under the designation of *W. peloritana*, but it was subsequently recognized by Mr. Jeffreys, Sig. Sequenza, and myself to be referable to the still existing *Wald. septigera* of Loven. Mr. Jeffreys is still, however, impressed with the idea that both *W. septigera* and *W. peloritana* should be considered synonyms of Philippi's

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[1] For the better understanding of the various Eocene localities referred to in this paper, it may be mentioned that a great alluvial depression extends between Vicenza and Schio. It is in the hill to the west of this depression that are situated Castelvecchio, Bolca, Chiampo, Malo, St. Giovanni Ilarione, Val di Lonte, Gambugliano, Castelgomberto, and St. Urbano. In the hills to the east, in the direction of Bassano, we find Lugo, Laverda, Crosara; and still further to the east the Valle Organa and Castelcies, which are beyond Brenta, near Possagno; on the contrary Mossano, Lonigo, and Brendola are in the chain of hills known by the name of Colli Berici, which extend to the south of Vicenza, and between that town and the Monti Euganei.

T. septata, but Sig. Sequenza assures me that the loop in *T. septata* sends off lateral branches which become attached to the septum in the dorsal valve (Pl. XIX., Fig. 10), while in *W. septigera* these lateral processes would not exist, the loop retaining the characters of *Waldheimia* (Pl. XIX., Fig. 16). *W. septigera* has, I believe, been collected from the Middle Miocene of Serravalle di Scrivia. In the Lower Pliocene at St. Filippo, Gravitelli, etc., near Messina. In the Upper Pliocene, in Calabria and Messina. In the recent State it has been dredged by Loven at Finmark, and by Dr. Carpenter and Mr. J. G. Jeffreys at a depth of 345 fathoms, between the islands of Shetland and Fœröe; and again recently (Porcupine expedition by Mr. Jeffreys, at from 165 to 175 miles south of the Scilly isles, and at about 185 miles from Ushant).

31. *Waldheimia cranium* (Müller), Pl. XIX., Fig. 11, 12. Zool. Dan. Prod. p. 249, No. 3006, 1776. = *Ter. euthyra* (Philippi), Enum. Moll. Sic., vol. 2, p. 68, pl. xviii., fig. 8, 1844. *Macandrevia cranium* (King), Proceedings of the Dublin University Zoological and Botanical Association, vol. 1, part 3, p. 201, 1859.

Mr. Jeffreys has for some time past entertained the opinion that *Ter. euthyra* is the fossil representative of the recent *Wald. cranium* and Sig. Sequenza is now disposed to adopt the same conclusion. The loop of the fossil was figured by Dr. Suess in the German edition of my General Introduction (Pl. I. Fig. 5, 1856), and it agrees with that of *W. cranium*. Dr. Carpenter believes that the deflected portion of skeleton or loop is connected with the lower portion on each side by a slight suture that may be easily ruptured, but if this is really the case in all examples, of which I am by no means certain, it would not alter the main character or shape of the loop, which is essentially that belonging to the genus or sub-genus *Waldheimia*. I am well aware that Prof. W. King has proposed that this species should serve as the type of a new genus *Macandrevia*, but I hardly imagine that the small differences that it presents in some of its internal details would warrant its complete generic separation from *Waldheimia*, but I am willing to admit that a difference of opinion may be entertained upon this point, and I merely offer my own view upon the subject. The fossil specimens of *W. cranium* do not appear to attain quite the dimensions of the full grown recent shell, but as has been shown both by Messrs. MacAndrew and Jeffreys, the living shell is a northern type and becomes consequently smaller and more stunted in its growth as it deviates in a southern direction from its more favoured northern habitat; the last dwarfed representatives of the species having been dredged by Mr. MacAndrew, at Vigo Bay. It abounds in the recent state at Uddevalla, east Loffoden, Christianiaford, etc. In the older Pliocene it occurs near Messina in Sicily, where it does not appear to be very abundant, and I may also observe that some Sicilian specimens present a median depression in the dorsal valve, which I have not observed in any of the recent examples.

32. *Waldheimia ? Davidsoniana* (Sequenza), Pl. XIX., Fig. 13, 13*a*. Sicilian Brachiopoda, pl. v. fig. 1–6, 1865.

In external shape this small species much resembles *T. minor*, but its interior is so dissimilar to it, as well as to that of *Waldheimia*, that Sig. Sequenza seems to think that it will be necessary to create a sub-section for its reception. It occurs in the Upper Pliocene of Gravitelli, near Messina.

83. *Waldheimia? depressa* (Sequenza), Pl. XIX., Fig. 14. Sicilian Brachiopoda, pl. v. fig. 15, 16.

This is a very minute shell, to which the same palæontologist had, in 1862, applied the designation of *T. pusilla*. Sig. Sequenza has recently informed me that it will be perhaps necessary to suppress it entirely. I have never seen the shell, nor do I believe Sig. Sequenza has ever seen its loop. It occurs in the older Pliocene of Rometta, near Messina, where the shell appears to be very rare.

34. *Terebratella septata* (Philippi), Pl. XIX., fig. 9, 10. Enum. Moll. Siciliæ, vol. 2, p. 68, tab. xviii., fig. 7, 1844.

This shell has been well described by Philippi and Sequenza. In external shape it does not seem to differ very much from *W. septigera*, but has its beak more incurved and its beak ridges sharply defined, a character not present in the last named species. The loop in *T. septata* is undoubtedly that of a *Terebratella* (Pl. XIX., Fig. 10) while that of *W. septigera* would agree with that of *Waldheimia*. It occurs in the older and newer Pliocene of Lamato and Nasiti in Calabria, and abounds likewise in several localities near Messina.

35. *Terebratella? Spinellii* (Meneghini), M.S. Pl. XIX., Fig. 17.

Shell longitudinally oval, sides and front rounded, valves almost gibbous and uniformily convex without fold or sinus; beak small and truncated by a circular foramen; each valve is ornamented with about 22 small rounded simple ribs. Interior not known, but on the exterior of the dorsal valve a dark line extends from the umbo to about half the length of the valve, indicating the presence of an internal septum, which may possibly have afforded a second attachment to the loop. Length 7, width 5½, depth 5 lines.

A single specimen of this shell was obtained by Sig. Meneghini in the volcanic tuffas of the Nummulitic or Eocene formation at Chiampo in the Vicentin. It bears much outward resemblance to some small specimens of *Terebratella oblonga*, but is a more inflated shell.

36. *Megerlia truncata* (Linné), Plate XXI., Fig. 1, 2.

This is a well known but very variable shell, and I fear that more that one so-termed species has been fabricated out of some of its variations. In external shape it is usually more or less semi-circular and wider than long, but it is likewise sometimes almost circular, and more or less strongly marked by numerous fine dichotomous thread-like radii, these being scarcely visible on some specimens, while they are more or less distinctly seen on others; these small ribs are also granulated in some specimens. It evidently existed during the Miocene and Pliocene periods, and is a common shell in the Mediterranean. In the Miocene it occurs at Grangia, in Piedmont, and was found also in the same formation in Tuscany by Sig. Meneghini. It is very common in the older and newer Pliocene of Calabria and Sicily, nor is it a rare fossil in the Island of Malta, at Nice, Gibraltar, and in many other places.

36. *Megerlia oblita* (Michelotti), Pl. XXI., Fig. 3, *Orthis oblita* (Michelotti), Fossiles des Terrains Miocènes de l'Italie Septentrionale p. 78, pl. 2, fig. 3.

I am very doubtful whether this so-termed species be distinct from *M. truncata*, but as Sig. Michelotti seems to be so strongly impressed with the idea that it possesses differences of specific value, I will provisionally record it under its distinctive appellation. I have not myself seen more of it than a ventral valve, and consequently must not pronounce a decided opinion upon the subject. Its surface, according to Sig. Michelotti, would be smooth and marked by concentric lines of growth only. It occurs in the Middle Miocene of the Hill of Turin.

37. *Megerlia* (?) *orbicularis* (Meneghini), M.S., Pl. XXI., Fig. 4, 4a.

Shell small, circular, about as wide as long; dorsal valve most convex at the umbo, gently concave towards the front; ventral valve uniformly convex, beak incurved, foramen large. Surface marked with numerous thread-like striæ. Interior not known. Length and breadth about five lines. Two examples of this small shell were found by Sig. Meneghini in the Upper Miocene of St. Dalmazio (near the Pomarane), and at Palazzo, near Siena. I have not seen the shell but several very fine drawings of it were kindly forwarded to me by the distinguished palæontologist above named. I should not be surprised if *M. oblita* and *M. orbicularis* were varieties only of *M. truncata*.

38. *Platidia* (*Morrisia*) *anomioides* (Scacchi Sp.), Pl. XXI., Fig. 15. *Orthis anomioides* (Scacchi and Philippi). Enum. Moll. Sicil., vol. 2, p. 69, 1844. *Platidia anomioides* (Costa). Fauna del regno di Napoli, p. 48, pl. iii., fig. 4, and pl. iii *bis*., fig. 6, 1852.

This well-known species occurs fossil in the Lower Pliocene in various localities near Messina, and is found alive in the Mediterranean. Mr. Jeffreys dredged one or two large examples between Shetland and the Færöe Islands (Porcupine Expedition, 1869). It had also received the name of *appressa* from E. Forbes.

39. *Platidia* (*Morrisia*) *Davidsoni* (Deslongchamps), Pl. XXI., Fig. 16. *Morrisia Davidsoni* (Desl.). Annals and Mag. of Nat. Hist., second series, vol. 16, pl. x., fig. 20, 1855.

Some examples of this species were found by Sig. Sequenza in the Quaternary deposits of Trapani in Sicily, and it is found alive in the Mediterranean.

40. *Argiope decollata* (Chemnitz. Sp.), Pl. XXI, Fig. 5, 5a, and 6, 7, 8. ?

This is a very variable species and seems to have enjoyed a considerable vertical as well as horizontal range. Its first appearance (if we correctly identify some small specimens, Pl. XXI., Fig. 6, 7, 8, found by M. Bayan) would take place in the lower part of his Eocene stage F. This same shell was also found by Sig. Michelotti in the Lower Miocene of St. Liberta in the Vicentin territory. It occurs in the Middle Miocene of the Hill of Turin, and is not rare in beds of the same epoch in Tuscany.. It was found along with *Crania abnormis*, in a sand near the Hospital of St. Colombano, a locality situated on a small hill in the plain of Lombardy, and in the territory of Lodi. This sand is a continuation of the Miocene of the Parmesan and Plaisentin, a spot celebrated from the occurrence of beautiful specimens of *Haliotis monilifera*. It occurs likewise, according to Sig. Meneghini, in the Upper Miocene of Parlascio and Palazzo in Tuscany; at Monte Gibio and near Messina. In the Older and Newer Pliocene, it is a common fossil in Tuscany, in Calabria, and especially near Messina. It has been collected from the quaternary deposits of Italy and is alive in the Mediterranean. It will also be seen from one or two of our figures that sometimes, after having attained a certain period of its growth, the extension of the ribs is suddenly stopped (Pl. XXI., Fig. 6-8), the shell continuing to extend, but without reproducing any of its ornaments; this I have also noticed to be the case in several recent examples of the same species.

41. *Argiope costulata* (Sequenza), Pl. XXI., Fig. 9, 9*a*, 9*b*. Piedmontese Brachiopoda. Annali dell' Accad. degli Aspiranti Naturalisti di Napoli, third series, vol. vi., pl. 2, fig. 2, 1866.

I know very little about this species (?), which seems to approach by its external and internal characters to *Argiope cuneata* of Risso. Its single septum in the dorsal valve removes it at once from *A. decollata*. A single example was found by Sig. Rovasenda in the Middle Miocene of Baldissero in Piedmont. More specimens will have to be collected and examined before its specific claims can be properly ascertained.

42. *Argiope cuneata* (Risso). Histoire Nat. des Principales productions de l'Europe Méridionale, vol. iv., p. 388, fig. 179, 1826.

This species is stated by Sig. Sequenza to occur in the Quaternary deposits of Sicily, but as I have never seen any fossil specimens I cannot do more than to record his statement. It is found alive in the Mediterranean.

43. *Argiope Neapolitana* (Scacchi sp.), Pl. XXI., Fig. 10. Scacchi Oss. Zool., p. 18, 1833, and Philippi Enum. Moll. Sicil., vol. i., p. vi., fig. 15, 1836.

Two or three specimens of this well-known species were found by Sig. Meneghini in the Pliocene of Siena. When quite young it does not always exhibit those two or four rounded ribs which occur in middle-aged and adult individuals, and in this early condition may be sometimes mistaken for *A. lunifera* or *A. cistellula*. I am, therefore, uncertain whether the minute specimen (Pl. XXI., Fig. 11) which was found by Sig. Meneghini in the same deposit and locality, and which was identified by him with the *A. variolata* (Sold.), (Saggio Tav. 150, fig. 293) may not be referable to one of the above-named species. In his work, "Fauna del Regno di Napoli," pl. iii., fig. 5, Prof. Costa has figured a specimen of *A. Neapolitana* without ribs.

44, *Argiope lunifera* (Philippi), Pl. XXI., Fig. 12. *Terebratula* (afterwards *Orthis*) *lunifera* (Philippi). Moll. Sicil., vol. i., p. 97, and pl. 4. fig. 16, *a. b.*, 1836. *Argiope cistellula* (Wood., Sequenza). Sicilian Brachiopoda, p. 71, pl. viii., fig. 7.

Mr. Jeffreys assures me that after a careful study of the *Terebra-*

tula lunifera and *Argiope cistellula*, he has arrived at the conclusion that they are both referable to a single species. Sig. Sequenza quotes *A. cistellula* from the Lower Pliocene of Rometta and Milazzo, near Messina; it is also found in the Quaternary deposits of the same island, and is alive in the Mediterranean.

45. *Argiope lævis* (Sequenza), Pl. XXI., Fig. 13, 13*a*. Piedmontese Brachiopoda. Annali dell' Accad. degli Aspiranti Naturalisti di Napoli, third series, vol. vi., pl. 3, fig. 2, 1866.

Whether this species be distinct from the *A. lunifera* or *A. cistellula* has still to be determined. Sig. Sequenza observes that it approaches to the last named species, as well as to *A. Neapolitana*, but most so to *A. megalocephala* (Sandberger). It was found by Sig. Rovasenda in the Middle Miocene of Grangia in the Hill of Turin.

46. *Argiope* (?) *Rovasendina* (Dav.) Pl. XXI., Fig. 14, 14*a. b. c. d.* Shell minute, compressed, almost circular, wider than long, sides and front rounded, ventral valve slightly convex, beak hardly projecting and gently incurved; hinge-line straight, rather more than half the width of the shell; hinge-area triangular, flat; foramen large, laterally margined by a deltidium. Dorsal valve semicircular and very slightly convex, less deep than the opposite valve, and most convex at the umbo; cardinal angles obtuse, hinge-area narrow. Surface smooth, marked only by a few concentric lines of growth; shell largely punctured. Length 2½, width 3, depth 1 line. I have examined five examples of this interesting little species, which were found by M. Bayan in his Oligocene stage I. or bed with Bryozoa at Monté Sgreve di Sant Urbano, and not far from Vicenza. In these beds occur, likewise, many examples of *Scutella subrotunda*. None of the specimens exhibit the interior so that I cannot feel certain with reference to the genus to which it should be referred. It has much of the external size and shape of some forms of *Platidia* or *Morrisia*, but does not show the horse-shoe shaped aperture in the smaller valve, so characteristic of that genus. I have consequently provisionally left it with *Argiope*.

47. *Thecidium Mediterraneum* (Risso), Pl. XXI., Fig. 17, 17*a*, *b*, 18, 19. Risso Hist. Nat. des Principales Productions de l'Europe Méridionale, vol. iv., p. 344, 1826. *Thecidium testudinarium* (Michelotti). Annali delle Scienze del Regno Lombardo-Veneto, 1840.

This is a well-known species, and I had occasion to describe several of its varieties, both recent and fossil in the Geological Magazine, Vol. I., 1864, to which the student is referred. Specimens agreeing with those from the Lower Miocene or Oligocene of Bernburg have been found by M. Bayan at Gambugliano and Crosara in the upper portion of his Eocene stage F. The same geologist has also procured it from his stage H. at Castel Goberto, this last locality being situated in the upper portion of his Oligocene ór Lower Miocene of Lyell. In the Middle Miocene it occurs in abundance in the Hill of Turin, at Parlascio in Tuscany, and is alive in the Mediterranean. It is not rare in the Island of Malta, at Peyrehorade (Landes), and in several other continental localities.

(*To be concluded in the October Number.*)

EXPLANATION OF PLATES XIX. AND XX.

PLATE XIX.

FIG. 1. *Terebratula grandis* (Blum.), Pliocene, Monté Mario, Rome.

2. *Terebratula ampulla* (Brocchi), Sp., after Brocchi's original figure, Piacentino.

3. *Terebratula Regnolii* (Meneg.), Upper Miocene, Parlascio, and from a drawing by Sig. Meneghini. His collection.

4. *Terebratula Roncioni* (Meneg.), from a drawing by Meneghini. His collection. Pliocene, Hills of Pisa.

5. *Terebratula Lyelliana* (Sequenza), Pliocene, Sicily.

6, 7. *Terebratula Galeottina* (Dav.), Middle Miocene, Gassino.

8. *Terebratula rhomboidea* (Biondi), Eocene? Cape Pachino, Sicily, after Biondi.

9, 10. *Terebratella septata* (Philippi). 9. Exterior; 10. Interior of dorsal valve, Older Pliocene, Messina.

11, 12. *Waldheimia cranium* (Müller) = *T. euthyra* (Philippi). 11. Exterior; 12. Interior of dorsal valve, enlarged from a figure by Dr. Suess. Older Pliocene, Messina.

13, 13*a*, *Waldheimia ? Davidsoniana* (Seq.). 13. Exterior; 13*a*. Interior of dorsal valve, enlarged after Sequenza. Upper Pliocene, Messina.

14. *Waldheimia ? depressa* (Seq.), Older Pliocene, Messina, after Sequenza.

15, 16. *Waldheimia septigera* (Loven) = *W. peloritana* (Seq.). 15. Exterior; 16. Interior of dorsal valve. Lower Pliocene, near Messina.

17. *Terebratella ? Spinellii* (Meneg.), Eocene, Chiampo, collection of Sig. Meneghini.

18. *Terebratula Voglianei* (Michelotti), Lower Miocene, Dego.

19. *Terebratulina caput-serpentis* (Linné) Middle Miocene, Grangia, collection of Sig. Rovasenda.

20, 20*a*. *Terebratulina Tauriniensis* (Seq.), Middle Miocene, Gassino, collection of Sig. Rovasenda. 20*a*. Enlarged.

21, 21*a*. *Terebratulina striatula* (Sow ?), Eocene, Valle Organa, environs of Bassano. Mus. of Imp. School of Mines, Paris. 21*a*. Enlarged.

22, 22*a*. *Terebratulina Michelottina* (Dav.), Eocene, Colle Berici. Mus. Imp. School of Mines, Paris. 22*a*, *b*, *c*. Enlarged.

PLATE XX.

FIG. 1, 2, 3. *Rhynchonella bipartita* (Brocchi), after drawings by Sig. Meneghini. Upper Miocene, Palazzo, near Siena. His collection. 2 and 3. Var. *plicato-dentata* of Costa.

4, 4*a*. *Rhynchonella Bolcensis* (Massalongo), Eocene, Bolca. Mus. Imp. School of Mines, Paris. 4*a*. Enlarged.

5. *Rhynchonella complanata* (Brocchi), Middle Miocene, Gassino.

6. *Rhynchonella sicula* (Seq.), M.S., Older Pliocene, near Messina.

7. *Rhynchonella Meneghiniana* (Dav.), Eocene, Bolca, collection of Sig. Meneghini.

8, 13. *Rhynchonella Buchii* (Michelotti), different forms and ages. 13. *Rhynchonella deformata* (Seq.), Middle Miocene, Hill of Turin.

14, 19. *Rhynchonella polymorpha* (Massalongo), different varieties and ages, Eocene, Monte Spilecco, near Bolca, Zovo di Castelvecchio, etc., from different collections.

III.—On the Transition Beds between the Devonian and Silurian Rocks.

By Alfred Marston, Esq., Ludlow.

THE transition or passage-beds between any two large formations are always difficult to make out, and those between the Old Red Sandstone and the Silurian are no exception to the rule. Much light has recently been thrown upon the latter, yet much more is needed before the exact order and position of their different beds can be considered as finally decided.

I include in these "transition beds" all from the top of the Upper Ludlow to some thin flaggy micaceous sandstones, which I consider the base of the Old Red. The junction of these beds with the Old Red Sandstone may be observed in the section on the Shrewsbury and Hereford Railway, near the Ludlow Tunnel, and also at the Tin Mills near Downton. The lowest of these transition beds is the Downton Sandstone, the commencement of which I would fix at the *Platyschisma* bed, which is a well defined line, and where it partakes in some measure of the Upper Ludlow character of rock. The principal fossils found in it are Lycopodiaceous seeds, *Pteraspis Banksii*, *P. truncatus*, *Eurypterus linearis*, *Pterygotus gigas*, *P. Banksii*, *Leperditia marginata*, *Beyrichia Klœdeni*, *Annelids*, Carbonaceous remains, a species of *Modiolopsis*, and *Lingula cornea*. Of these fossils, *Leperditia marginata* has not been found in the Upper Ludlow, and *Eurypterus*, *Pterygotus*, and *Pteraspis* are much more abundant in the Downton Sandstone than in the underlying rock; all of which fossils reach their greatest development in the thin band occurring about 300 feet higher up, called the Olive or Tin Mill Shale. *Eurypterus linearis* has been found in the Upper Ludlow, a few feet below the Downton Sandstone, and just above occurs the Bone Bed, a stratum from 1 to 6 inches thick, composed of fragments of fish and crustacean remains.

The Downton Sandstone is composed of fine yellow-coloured sandstone, deposited in a tranquil sea, the currents of which for long periods carried the same materials; it had, therefore, everything favourable for the preservation of its organic life. Between this rock and the next to be described occurs a series of different coloured bands of sandstone, showing great irregularity in their formation, which is not favourable to the preservation of their fossil contents, and consequently in these beds we find a scarcity of organic remains; I only know of one organism obtained from them, the small *Beyrichia*. The next bed is a greenish-grey sandstone, strongly micaceous; the only fossils that have yet been found in it being *Cephalaspis Murchisoni*, *Lingula cornea*, and a few Carbonaceous remains. This bed may be observed in position in the lane leading from Onibury to Norton, and at the Tin Mills near Downton.

We next come to the Olive shales, which are thin light-brown argillaceous beds, very brittle and full of fossils, and these latter generally occurring in thick masses. About the centre of these beds is the Upper Bone Bed, from whence very fine spines of *Onchus Murchisoni*, *Onchus tenuistriatus* have been procured, also fragmentary remains of *Cephalaspis Murchisoni*, *C. ornatus*, *Auchenaspis Salteri*, etc. From the Olive or Tin Mill Shale has been procured *Pterygotus Banksii*, *Eurypterus pygmæus*, *E. megalops*, and *E. acuminatus*; *Leperditia marginata*, *Beyrichia* sp. remains of plants, a species of *Actinophyllum*, a new *Modiolopsis* and *Lingula cornea*. The best sections at present known may be seen on the Shrewsbury and Hereford Railway, at the Tin Mills, and near Onibury.

Immediately above the Olive Shale is a hard band of purple micaceous grit, full of large specimens of *Lingula cornea*, this bed is well exposed at the Tin Mills. Lying above these purple beds is a bed of grey sandstone, very barren, the only remains yet brought to light being *Lingula cornea* and carbonaceous markings, and these very scarce and imperfect. This bed may be best examined near Onibury. Immediately above this last rock are the thin, flaggy, micaceous sandstones, the base of the Old Red, in which beds not a single trace of organic life has yet been observed; yet I have no doubt that further search will be rewarded by the discovery of traces of *Pterygotus*, *Pteraspis*, and *Cephalaspis*, as they are found both below and above them, and consequently must have lived not very far off during the period of their deposition.

IV.—ON A NEW LARGE *TEREBRATULA* OCCURRING IN EAST ANGLIA.

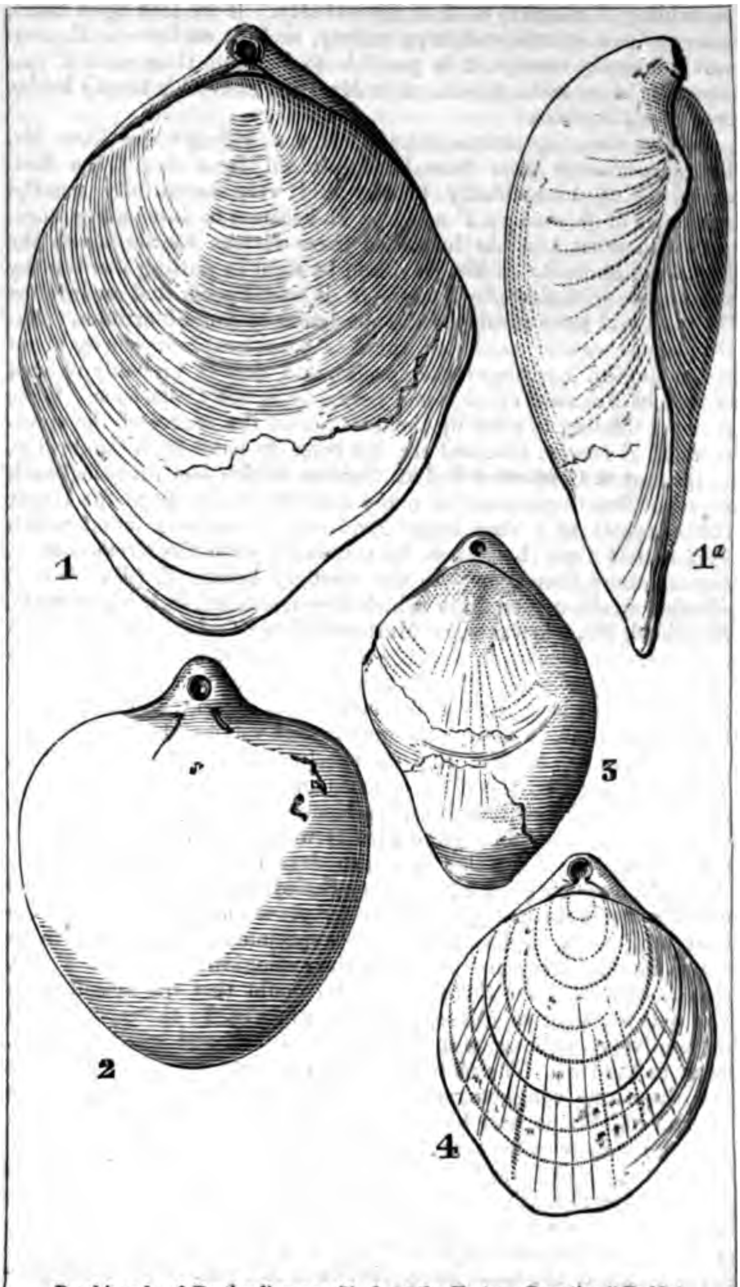
By E. RAY LANKESTER, B.A., Coutts Geological Scholar, Oxford.

(With a Wood Engraving.)

THE forms which Mr. Davidson in his invaluable Monograph has included under *T. ovoides*, are so various that it would be possible to refer the shells figured in the plate to that species, but since *T. trilineata*, from the Inferior Oolite, and *T. lata* and *T. ovoides*, from drift-blocks—which I shall endeavour to show are of the very latest Jurassic horizon—are very different in many respects, I prefer to give a new name to this form, which may find its place near *T. ovoides* and *T. simplex*. The specimen drawn, Fig. 1 and 1*a*, is from the collection of Mr. Roper of Lowestoft, who obtained it, with another specimen, from a gravel-pit at Thorpe in Suffolk. It has the general simple form of *T. ovoides*, but is remarkable for its great size. The imperforate valve is flattened in the mesial line, whilst the perforate valve is deep and raised into a well-pronounced keel in the mesial line extending from the beak; the foramen is small. The specimen figured is longer than the other in Mr. Roper's collection, which has the shorter, squarer form of Fig. 2, resembling *T. simplex*. This fine *Terebratula* may be known as *T. rex*.

In the British Museum and in the Ipswich Museum are portions of a block crowded with a *Terebratula*. The block was found by Mr. Charlesworth in a gravel-pit near Snape in Suffolk. The specimens in the fragment in the British Museum present a family likeness to *T. rex*, but they are shorter, squarer, and fuller, the imperforate valve being slightly convex. The block which contains them is evidently the same matrix as that which embedded Mr. Roper's *T. rex*, whilst Mr. Roper's specimens are like unwieldy examples of Sowerby's *T. ovoides*—bearing the same relation to the well-marked specimens, such as Mr. Rose's from Stow-Bardolph, No. 44,503 in the British Museum as do the irregular gigantic specimens of *T. depressa* from Upware to the beautiful and really elegant *T. nerviensis* of Belgium. It is difficult to look upon the specimens from Snape in this way, and the late Dr. Woodward had, we find, indicated *T. homologaster* (a Brown Jura species from Würtemburg resembling *T. simplex*) as their nearest ally. If we look upon them, however, as a square or stumpy variety, such as we have in *T. perovalis* commonly enough, it is possible to associate them with *T. rex*, especially since some specimens in Mr. Charlesworth's blocks bridge over the differences.

Besides these specimens from Thorpe and Snape, we have Mr. Rose's specimens from Stow-Bardolph, all from drift; the last-named being undoubtedly typical and very beautifully marked specimens of Sowerby's *T. ovoides*. It becomes an interesting question as to what bed has furnished these various *Terebratulæ* to the East Anglian drift. If Mr. Davidson be right in putting the Whitby *T. trilineata* with Sowerby's *T. ovoides*, it would seem that an Inferior Oolite should have furnished the specimens of Suffolk erratics. Mr. Davidson, however, says that there is considerable obscurity about the geological horizon of the species, and that it probably existed in various Jurassic epochs, and certainly is not Cretaceous. Some evidence tending to clear up the question of the source of the specimens of *T. ovoides*, *lata*, and *rex*, has come to hand from Cambridge. In the Lower Greensand bed at Upware, which has furnished such beautiful Brachiopoda and so many derived remains from the Upper Oolites, casts of a very large *Terebratula* have been found which were at one time thought to be connected with the Cretaceous *T. depressa* there found, or with the strongly keeled *T.* (*Waldheimia*) *Woodwardii* discovered there, which they resembled in being carinate. My friend, Mr. Earwaker, of Merton College, Oxford, showed me a considerable series of these large casts, and that drawn in Fig. 2 is one of his specimens. It is evident from their water-worn state that they have been derived from an earlier deposit, and the resemblance they bear, in their carinate perforate valve and depressed imperforate valve, to Mr. Roper's specimens of *T. rex* is obvious. That drawn in Fig. 2 is about the size and form of one of the square specimens in the British Museum block from Snape, whilst others of a more elongate form (like Fig. 1) were also in Mr. Earwaker's possession. Mr. Earwaker has also drawn my attention to some *Terebratulæ* which he and Mr. Harry Seeley, of Cambridge, knocked out of a block, in company *with other fossils*, at Herrmiere on the Cam, not far from Upware. These specimens, one of which is drawn in Fig. 3, promise to decide the geological horizon of *T. rex*, *ovoides*, and *lata;* for there can be no doubt that the specimen in Fig. 3 is the same species as that drawn in Fig. 1; the carination of the one valve, depression mesially of the other, and small foramen, agree in the two. The matrix in which this specimen occurred is a fine sandstone conglomerate, closely resembling the matrix from Thorpe and Snape, and having small black pebbles scattered in it. Mr. Seeley informs me that it is *in situ* beneath the bed of the Cam, between Ely and Upware, and is often dredged up there. The fossils which came from the block which he broke with Mr. Earwaker, including species of *Belemnites*, *Trigonia*, etc., agree with the stratigraphical position of the bed, as the very highest of the Oolites,—Portlandian, if the name be applicable to this part of the country,—



Brachiopoda of Portlandian age (?), from the Eastern Counties "Drift."

intermediate between the Neocomian and Kimmeridge clay of the district. This being the case, there can be little doubt that a considerable mass of such Oolitic strata has been broken up by the eastern drift; and what is more interesting is that this very same action was going on at the time that the Greensand sea spread its numerous Brachiopoda over the Upware shore; then, as in the far later period, this Portlandian deposit furnished its fossil *Terebratulæ*, such as those from Upware, to mix with the reptiles from the Kimmeridge below and the yet recent shells and the bits and pebbles from all the northern coast-line.

EXPLANATION OF FIGURES (page 412).

FIG. 1. *Terebratula rex*, Lankester, from "Drift" Gravel-pit, Thorpe, Suffolk, in the collection of Mr. Roper, Lowestoft.
„ 1*a*. Side view of same.
„ 2. *T. rex*, from Upware, in the collection of Mr. Earwaker, Merton College, Oxford.
„ 3. *T. rex*, Herrmiere on the Cam, near Upware.
„ 4. *T. ovoides*, Sby. "Drift" Stow-Bardolph, Downham. Collected by C. B. Rose, Esq., and presented to the British Museum.

(All natural size.)

V.—CATALOGUE OF THE MAMMALIAN FOSSILS WHICH HAVE BEEN HITHERTO DISCOVERED IN IRELAND.[1]

By ROBERT H. SCOTT, M.A., F.R.S.

[NOTE.—In the June Number of the GEOLOGICAL MAGAZINE for the present year, page 253, we published an article by Prof. Harkness, F.R.S., "On the occurrence of Elephant-remains in Ireland." Having since had our attention directed to the subjoined paper by Mr. Robert H. Scott, F.R.S., we have requested and obtained the author's permission to publish it in our Journal, as we believe it to be the only Catalogue of Irish Fossil Mammalia extant, and it well deserves to be more widely known.—EDIT. GEOL. MAG.]

INASMUCH as the subject of the Fossil, or rather Sub-Fossil Mammalia of Ireland, has been brought rather prominently before the notice of the Society during the past two sessions, I have considered that it might not be devoid of interest to our members, if I were to place on record the various genera and species of that class of which remains have been hitherto found in Ireland. Such a communication as this does not make any claim to originality, and I shall endeavour, as far as I can, to give my authority for every statement of a fact which will be embodied in this Catalogue. The chief sources from which the information has been derived are Dr. Scouler's papers, in our "Journal," and those by Dr. Ball and Sir W. Wilde, in the "Proceedings of the Royal Irish Academy."

The following list contains those of which notices remain on record:[2]

1. *Ursus arctos.*
2. —— *spelæus.*
3. *Ursus maritimus.*
4. *Canis lupus.*

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[1] Appendix to the Annual Report for 1864, read before the Geological Society of Dublin, February 10, 1864.

[2] For a list of British Fossil Mammalia, etc., see paper by H. Woodward, entitled "Man and the Mammoth; being an account of the animals found associated with early man in prehistoric times." GEOL. MAG., 1869, Vol. VI., p. 58.—EDIT.

5. *Elephas, sp.*
6. *Hippopotamus.*
7. *Sus scrofa,*
8. *Bos frontosus.*
9. *Bos longifrons.*
10. *Cervus alces.*
11. *Cervus elaphus.*
12. *Megaceros Hibernicus.*
13. *Tarandus rangifer.*
14. *Ovis, sp.*
15. *Cetaceans.*

In this Catalogue I do not attempt to place on record the circumstances under which the remains have been found, unless in a few instances. To the list which I have given some more might be added; but these I do not consider to deserve the title of fossils,—such are the Fallow Deer, with many instances of Cetacean remains. On this point I need only remind the members that a few years ago an Armadillo was discovered walking about in a field in the county of Meath, having been thrown out of a travelling menagerie, in an apparently dying condition. Another similar instance is to be found in the case of the skeleton of the Lion which was found in the county of Carlow. Fortunately, before the account of this addition to our Irish fossil Fauna was quite ready for publication, an old man turned up who remembered the fact of a dead Lion having been thrown out of a menagerie some sixty years before, which, after being skinned, was buried in the field.

Bears.—Three species of bears have been hitherto discovered in Ireland, and the progress of geological discovery has been more rapid in respect of this animal than of any other. In 1843, Dr. Scouler noticed that no Bears had been observed in Ireland, and in the year 1846 the discovery of no less than four skulls had been placed on record. There is no record of the existence of Bears in Ireland, as is remarked by Dr. Scouler in his paper on the animals which have disappeared from Ireland.[1] The oft-quoted statement of St. Donatus, who died in 840, is considered conclusive on this point:—

> "Ursorum rabies nulla est ibi, sæva leonum
> Semina nec unquam Scotica terra tulit,
> Nulla venena nocent, nec serpens serpit in herbâ
> Nec conquesta canit garrula rana lacu."

The remaining evidence on the subject is entirely negative, and is derived from Giraldus Cambrensis and others. On the other hand, Sir W. Wilde[2] mentions that there is an Irish name for the animal in an old glossary in the Library of Trinity College, and Thompson mentions the existence of traditions of the animal.

In tracing the fossil Bears, I have derived much assistance from my friend, Dr. W. Frazer, one of our members, who has interested himself much in the matter.

Ursus arctos.—The first Bears' skulls were obtained by Mr. Underwood, who said that he found two in the county of Longford, in 1846. These were bought by A. W. Baker, Esq.

Dr. Ball was permitted to take casts of the two skulls, which he presented to the Royal Irish Academy in 1846;[3] and at the same time he presented a cast of a third skull, which was in the possession of Mr. Cooke, of Parsonstown, and is now in the British Museum. It was found in deepening a river near Colonel Bernard's property, in the King's County. These casts are now at the Royal Dublin Society These skulls Dr. Ball pronounced to be those of the brown Bear, *U. arctos*, and in this opinion he was confirmed by Professor Owen, to whom he submitted casts of the skulls.

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[1] "Journal of the Geological Society of Dublin," vol. i., p. 228.
[2] "Proceedings of the Royal Irish Academy," vol. vii., p. 193.
[3] "Proceedings of the Royal Irish Academy," vol. iv., p. 416.

Mr. Gray discovered the skull of a bear, as described in the accompanying letter:—

"Clonliffe Parade, January 24, 1863.

"My Dear Doctor,—The bear's head, to which you referred in your letter of the 10th instant, was found a little above Leinster Bridge, in the barony of Carberry, and county of Kildare. It was imbedded in peat or sand, about 4 feet below the surface, in a sort of valley or hollow, through which the River Boyne flowed; and if you refer to the fifth volume of the 'Proceedings of the Royal Irish Academy,' p. 53 of the Appendix, you will find a report of mine, describing a lot of articles found while engaged in the arterial drainage of some important rivers in Kildare, Meath, Westmeath, and the King's County. These are all in some degree descriptive of the locality; and if you are following up the subject, you may derive some ideas from the facts I have stated. The bear's head was got along with a great quantity of the bones and heads of the deer; and they were collected together in a position that would give the idea of their having been floated together, and deposited in an eddy or still bend of the river. There were a quantity of the bear's bones along with the head when it was found, but they were destroyed by the men who found them, *although they were not much decomposed.* Some of them were very short and strong—not such as you mentioned to me, but were, perhaps, nine inches in circumference, and about 15 inches in length. They were destroyed by the men having used them to knock the earth out of the barrows, etc., by striking them till broken.

"There was no marl in the neighbourhood. If you refer to page 35 of Appendix to vol. v. of the Royal Irish Academy's 'Proceedings,' before referred to, you will have a description of the locality. The bone dirk (No. 15) alluded to was found about half a mile or less below where the bear's head was got, and in the same river-course.

"I suppose you have seen the skull; it is in the Museum of the Academy, and I suspect about the most perfect of its class. Any other information I can afford you relative to such matters will afford me much pleasure; and I trust you will excuse my not having replied to your letter before this.—Yours faithfully,

"William Frazer, Esq., M.D." "Richard A. Gray.

It was presented by him to the Royal Irish Academy, among the donations from the Board of Works, and is now at the Royal Dublin Society. It is figured by Sir W. Wilde.[1]

In March, 1859, Mr. Brenan and Dr. Carte discovered some remains of *U. arctos;* among others, a mutilated cranium, in the cave at Dungarvan.[2] The other bones were—the left lower jaw, the atlas, two cervical, two dorsal, and two lumbar vertebræ, with several broken ribs.

About the year 1860, Mr. Going,[3] of Violet Hill, Broadford,

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[1] "Proceedings of the the Royal Irish Academy," vol. v., App., 54, vii.

[2] "Journal of the Royal Dublin Society," vol. ii., p. 451.

[3] On applying to Mr. Going for further information on this subject, I received the following letter, which he has kindly permitted me to print:—

"Violet Hill, Broadford, June 20, 1864.

"Sir,—I beg to acknowledge the receipt of your letter of the 17th inst., and will feel happy at affording you all the information I can relative to the finding of the animal remains you allude to in this locality.

"Some years since, my men, in draining a small boggy hollow, found a quantity of bones under the bog, in the blue clay. The bones were evidently those of some animal *much* larger than any dog, being stronger in proportion to their length, and county of Clare, discovered a skull, about twelve inches long, and of the shape of the skull of *U. arctos.*[1]

Lastly, within the last year, Mr. W. H. Gregory, M,P., of Coole Park, near Gort, kindly offered to examine the caves in his park with Mr. Jukes, who has furnished me with the following account. About 100 yards from the mouth of the cave, which is in low ground, and full of water in wet weather, a crust of stalagmite was broken through. This was in some places eight or ten inches thick; underneath it was an irregular mass of fine brown clay, from two to four feet thick. After digging out a great quantity of this clay, without finding anything at all, the bones of a small animal were at length met with, and among them a small fragment of a jaw, with two teeth in it. This fragment was afterwards examined by Mr. Blyth, and the teeth said to be the hindmost false molar (or carnassial), and the next false, or premolar, of a young Bear (*Ursus arctos*), being the deciduary or milk teeth of the right side of the upper jaw.[2]

U. spelæus.—Portions of the skeleton of this species, probably of a female specimen, were discovered among the other bones found at Shandon, Dungarvan. The cranium was not discovered, but the bones which were found exhibited the marked characteristics of *U. spelæus.*

U. maritimus.—At the January meeting of the Society, Dr. Carte announced the discovery of a few bones of an animal belonging to this species at Lough Gur. The recollection of this paper is so fresh, that I need hardly remind you of it. The account will be found at p. 114, vol. x., of the "Journal." In this case, as in the foregoing, the cranium has not yet been found.

In Archdeacon Maunsell's well-known letter about the skeleton of

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exactly similar, as far as I and some friends could judge, to the skeleton of a large bear. The skull was about twelve inches long, but the nose part was broken off, and very much resembled the *shape* of a Badger's skull, but about the *size* of a large Bear's. Most unfortunately, I regret to state, these bones were not preserved. The skull was kept for some time, but has been lost; but for which I should have much pleasure in sending it for your examination. Near the place where these bones were found, in a few days after, two large *tusks*, about eight or nine inches long each, were also turned up, with several teeth also, besides some bones and skulls of other animals, which were found in a bog, in a wood, when raising some large *black* oak trees, several feet under the surface. The latter skulls resemble the first alluded to, but were of smaller size. I regret very much now that I have not preserved them, with the exception of an Elk's head and antler, which I have heard stated is the largest found in this county, but not in the same place in which other remains were discovered. All those alluded to were clearly belonging to extinct animals.—I have the honour to remain, Sir, your obedient servant,

"R. H. Scott, Esq." "W. Quin Going.

[1] Explanation to Sheet 133 of the Map of the "Geological Survey of Ireland," p. 34.

[2] With reference to this identification, I have to subjoin the following letter, received since from Mr. Jukes:—

"Dublin May 10, 1864.

"My dear Mr. Scott,—I took over to London the other day the teeth which were found in Coole Park, and which Mr. Blyth informed me were those of a young brown Bear, and asked Professor Huxley to give me an opinion upon them. He examined them, and said they belonged to a young pig. So this case of the occurrence of *Ursus arctos* in Ireland fails.—Yours very truly, "J. B. Jukes."

the *Megaceros* at the Royal Dublin Society's Museum, printed in Dr. Carte's pamphlet, he mentions the discovery of a head of a large dog, at least of a carnivorous animal, which was found with the Deer at Rath-cannon, county of Limerick. It has been supposed by some to have been a Bear; but Archdeacon Maunsell would hardly have called it a Dog, if it did not closely resemble a Dog's skull.

Canis lupus.—The remains of Wolves and Dogs can hardly be distinguished one from the other. There are several skulls of a canine type which have been found in Ireland; some of them are said to be those of Wolves. Several of those specimens were obtained from Dunshaughlin.

The date of the extinction of Wolves is well known. In 1641, they were extremely troublesome. In 1652, a council order of Cromwell's government was made at Kilkenny, which prohibited the export of Wolf-dogs; and the reward for a bitch Wolf was £6; for a dog, £5. Smith, in his "History of Kerry," says the last was killed there in 1710. Mr. Hardiman, the editor of O'Flahertie's "Description of Iar-Connaught," pp. 10 and 180, gives some information on the subject, and says that the date of the death of the last Wolf in that district was 1700, as far as he could ascertain.

Elephas primigenius.—In the year 1715,[1] four teeth of an Elephant were found by Mr. Francis Nevil, at Maghery, eight miles from Belturbet, in sinking for the foundation of a mill. The finder did not know to what animal the teeth belonged, but suspected them to be Elephants' teeth; and this opinion was placed beyond a doubt by Dr. Thomas Molyneux, in an interesting letter, which follows the original communication.

In the year 1859,[2] Mr. E. Brenan, of Dungarvan, discovered a considerable portion of the skeleton of an Elephant in the cave at Shandon, near that town. The bones were associated with those of Bears and numerous other mammals.

In addition to these remains, Smith, in his "History of Waterford," p. 58, mentions the discovery of the rib of an Elephant within a mile of Whitechurch, not far from Dungarvan. He gives a figure of the rib, on a reduced scale, and it appears to resemble the rib of a Whale. It is quoted by Professor Oldham, in a paper read before the Geological Society of Dublin, on the 12th of June, 1844,[3] as the rib of a Whale, without any reason being assigned for its being so called.

Hippopotamus.—When the Ordnance Survey was in progress in the county of Antrim, in the vicinity of Carrickfergus a tusk of a Hippopotamus was found by a son of Mr. P. Doran, as will be seen from the accompanying letter, which I have received from my friend, Dr. David Moore, the Curator of the Glasnevin Botanical Gardens:—

"Glasnevin, February 5, 1864.

"My Dear Sir,—I have a clear recollection of the circumstance you mention about the tooth being found near Carrickfergus. Mr. Jukes applied to me some time ago to furnish him with all the information I could on the subject, which I did. The occurrence happened as follows:—In 1837, our office was in the Infantry Barracks, at Belfast. I had attached to my party several assistants, one of whom was the son of Mr. Patrick Doran, the mineral collector, whom I sent to Carrickfergus to collect plants, birds, fossils, etc. In his peregrinations he picked up the tooth in question, on the side of a stream, about a mile or less north-west of the town, on the rising ground towards the mountain. He described it to me as having been partly sticking out from a bed of gravel. I went to see the place afterwards, and, unless the locality be greatly altered since, would easily find it again. I gave the specimen (as was my duty) to General Portlock, who was then the commanding officer of the Geological and Natural History Departments.—Faithfully yours,

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[1] Boate, "Natural History of Ireland," p. 128. See also Phil. Trans. vol. xxix.

[2] "Journal of the Royal Dublin Society," vol. ii., p. 251.

[3] "Journal of the Geological Society of Dublin," vol. iii., p. 70.

"R. H. Scott, Esq." "D. Moore."

Sus.—A great number of Pigs' skulls have been discovered, especially in Lough Gur. These all belong to the old Irish long-faced variety, which is now fast disappearing. Many of them show the mark of the pole-axe on the forehead.

Bovidæ.—As regards the bovine animals, it has long been known that there are in Ireland two well-marked species of Oxen, whose remains are found fossil.

The gigantic species which is found in England, *Bos primigenius*, does not occur here, or at least has not been as yet discovered. The two species which are found, and of which specimens were presented by the Royal Irish Academy to the Royal Dublin Society, are the *Bos frontosus* of Nilsson, and the smaller species, *Bos longifrons*. Several of the skulls exhibit the mark of the pole-axe.

In a recent communication made to the Royal Irish Academy,[1] Mr. Blyth stated that the skulls which he found here were exactly similar to those found at Uriconium.

Cervidæ. Cervus alces.—A horn of the true Elk is said by Thompson to have been found, in the county of Tyrone, by a relative of his own. It was dug out of a bog near Stewartstown, and was presented to the Natural History Society of Belfast. Mr. Thompson mentioned the discovery in the "Proceedings of the Zoological Society of London" for 1837, and this notice was copied into his "Natural History of Ireland."[2]

Cervus megaceros.—The instances of the discovery of this animal are so numerous, that I shall only give a few cases of their being found in juxtaposition with bones of other animals and with other articles.

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[1] "Proceedings of the Royal Irish Academy," vol. viii, p. 472.

[2] With reference to this, Dr. Carte has received the following letters from Mr. Robert Patterson, of Belfast, which he has permitted me to print:—

"Belfast, February 10, 1864.

"My Dear Sir,—As my friend, Mr Hyndman, knew better than myself about the elk's horn in the Museum, I sent him your letter, and enclose his reply.

"Dr. Carte." "Yours very sincerely, Robert Patterson.

"'February 9, 1864.

"'My Dear Sir,—I have examined the elk's horn in the Museum, and I think the freshness of it, and the perfection of the points or tangs, forbid the supposition that it could ever have remained any lengthened time in the bog. Besides the paint upon it, mentioned by Thompson, there is a round hole bored through the broad plate of the horn, showing that at some period it had been put up as an ornament in some person's hall. It must have got into its position in the bog by some accident.

"'Robert Patterson, Esq.'" "'Yours very truly, George C. Hyndman.

This opinion of Mr. Hyndman has derived additional confirmation from a communication which I have received from a friend of mine, Mr. Bernard R. Ross, F.R.G.S., of the Hudson's Bay Company's Service, who, on examining the horn, pronounced it to be a North American specimen, and of no great antiquity.

It is, however, necessary to examine evidence of this nature with great care before receiving it. In the course of a discussion which took place before this Society on the 11th December, 1861,[1] some facts of interest were elicited. Dr. Petrie said that he had in his possession an iron sword which had been found, with the bones of a *Megaceros*, in the county of Meath; and Mr. Baily referred to the discovery of remains of the *Megaceros* which were found with spear-heads and pottery in a lake, in the canton of Berne, in Switzerland, as mentioned by Professor Morlot. The discovery of jet rings with the specimen in the Museum of the Royal Dublin Society, as noticed by Archdeacon Maunsell, was also alluded to. Two quotations from the "Book of Lismore" have also been recently brought under our notice, in which the chase of a large deer, supposed to be the *Megaceros*, is described. One of these was read on the evening to which we are referring, and the other in the course of Dr. Carte's paper on Lough Gur, which appears in this volume of the "Journal." In a paper by Mr. H. Denny, of Leeds,[2] "On the Claims of the Gigantic Irish Deer to be considered as contemporary with Man," there is a long discussion on this subject, from which I extract the following statements, which I have not verified personally:—The leg of a *Megaceros*, with a portion of the tendons, skin, and hair on it, was found in the county of Wexford, on the estate of H. Grogan Morgan, Esq., at Johnstown Castle. This specimen was sent to the Royal Dublin Society, and was exhibited by Mr. Peall, Professor of Veterinary Surgery, at his lectures.[3]

A very scarce book—a "History of Ireland," which is said to be by Peppard, published in the seventeenth century — contains a statement to the effect, that the ancient Irish lived on the flesh of a great black Deer; and similar information is said to have been obtained by the late Sir W. Betham from some brass or bronze tablets containing an inscription. This fact was mentioned by Mr. Glennon, of Suffolk-street, who with Mr. Richardson, carried on a long discussion on this subject in 1846, in the "Zoologist," and elsewhere. Several instances of the finding of bones of the *Megaceros* in company with other remains, are given by Mr. Denny, to whose paper I must refer you. In addition to the facts and statements just quoted, there is the evidence which may be derived from the existence of cuts, &c., on antlers and bones of the giant deer, which was discussed at considerable length by Mr. Jukes, and by the members who were present when his paper was read, in December last.[4]

It will be seen from what I have mentioned, that the evidence on this subject is in an unsatisfactory state: and although it is certain that the date of the extinction of the *Megaceros* in Ireland is, geologically speaking, very recent, yet it is a matter of opinion as to whether man was or was not the agent of its extermination.

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[1] "Journal of the Geological Society of Dublin," vol. ix., p. 339.

[2] "Proceedings of the Geological and Polytechnic Society of the West Riding of Yorkshire," vol. iii., p. 400.

[3] Unfortunately, this specimen appears to have been mislaid, and cannot now be found.

[4] Journal Geol. Soc. Dublin, vol. x. p. 127.

Cervus elaphus.—The fossil Red Deer is as abundant as, and even more so than, the preceding species. Some of the antlers found are very magnificent. One obtained from Ballinderry Lake, county of Westmeath, presented to this Society by Mr. Hamilton, in 1843, had nineteen points. A hundred years ago they were still very abundant in Erris and in Kerry. In the ninth century, Giraldus speaks of them as very fat, and therefore unable to escape from their foes; and O'Flahertie, in his "Description of West Connaught," written in 1684, mentions them, p. 121. They are generally known under the name of Marsh Deer, and Professor Haughton is of opinion that they are a variety of the Red Deer.

Cervus Dama.—Among the bones presented by the Royal Irish Academy to the Royal Dublin Society, there is a fragment of an antler of a Fallow Deer, described as an antler of a young Red Deer in the "Catalogue of Unmanufactured Remains." This is evidently not a fossil, as the date of the introduction of the Fallow Deer into the Continent of Europe is known. Thompson mentions the discovery of a Fallow Deer in a bog in the county of Antrim. The specimen was in his possession.

A skeleton of a Fallow Deer, with a silver collar round its neck, was found at the same time as Mr. Cook's Bear's skull, before referred to. It had belonged to some member of Lord Rosse's family.

Tarandus rangifer.—The history of all the specimens of this animal which have been discovered in Ireland was read before the Society in May, 1863, by Dr. Carte, and is, printed in vol. x. of the "Journal," p. 103.

Ovis.—In the collection of Mammalian remains at the Royal Dublin Society, which have been deposited there by the Royal Irish Academy, there are several skulls of Sheep, and a few Goats' skulls. Of the Sheep there are two well marked types—one possessing several horns, like the polycerate Sheep, at present existing in Iceland, and the other identical with the horned Sheep of the Highlands of Scotland, according to the notice published by Dr. Blyth, and before referred to. The same authority considers the Goat's skulls to be very recent.

Cetaceans.—Professor Scouler found the rib of a Whale in the marl beds of Wexford, as mentioned in his Presidential Address for 1844.[1] In addition to this, remains of the smaller Cetaceans are not uncommon in localities near the sea-side. There is a vertebra of a small Whale, or perhaps of a Porpoise, among the fossil bones in the Royal Irish Academy's collection. On this subject I may observe that a shoal of Ca'ing Whales was driven ashore some years ago on the sands to the west of Horn Head; the skeletons were buried in the sands.

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[1] Journal Geol. Soc. Dublin, vol. iii. p. 18.

VI.—REPLY TO M. DELAUNAY'S OBJECTIONS TO THE LATE MR. HOPKINS' METHOD OF DETERMINING THE THICKNESS OF THE EARTH'S CRUST, BY THE PRECESSION AND NUTATION OF THE EARTH'S AXIS. By Archdeacon PRATT, M.A., F.R.S., ETC.

To the Editor of the GEOLOGICAL MAGAZINE.[1]

SIR,—Having lately read the translation of a paper by M. Delaunay in your MAGAZINE of November, 1868, Vol. V., p. 507, and your commendatory notice of that gentleman's views regarding the late Mr. Hopkins' method of estimating the thickness of the earth's crust by Precession and Nutation, I beg to send you a paper in which I have endeavoured to vindicate that method and to point out where M. Delaunay appears to have mistaken it. Mr. Hopkins was no average mathematical physicist, and was not likely to have advanced a theory to be so easily refuted, as M. Delaunay's paper would impress readers not well versed in mathematical physics.—I am, etc.,

MURREE, HIMALAYAS.
May 29, 1870.

JOHN H. PRATT.

It is only two days ago that I saw for the first time M. Delaunay's strictures[2] upon the late Mr. Hopkins' method of ascertaining the least thickness of the Earth's Crust by means of the phenomena of Precession and Nutation, although I had previously seen a notice that such strictures had been laid before the French Academy. Having now that gentleman's paper before me, I write to endeavour to convince your readers that the point of Mr. Hopkins' reasoning has been altogether missed, and that his method stands altogether unimpaired by these strictures.

2. I am ready to allow, and so would Mr. Hopkins have allowed, that if the crust of the earth revolved round a steady axis, always parallel to itself in space, and if at some particular epoch a difference existed between the rate of movement of the crust and of the fluid within it, the resulting friction would gradually destroy this difference and bring about a conformity in the motion of both parts. I will even go further, and allow that the effect of the internal friction and viscidity of the fluid may be such that the resulting rotary motion may be the same as that which the whole mass would have had at the epoch if it had suddenly become one solid body and thereby suddenly retarded the rotation. This, before proceeding, I will illustrate by an example for the use of your mathematical readers.

3. Suppose a spherical shell or crust of mass C to have within it a solid spherical nucleus, of radius b and mass N, fitting it exactly; and the crust to receive an angular velocity of rotation around an axis fixed in the crust, the nucleus at that moment having no angular velocity; but suppose that a slight force of friction between the

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[1] We gladly publish Archdeacon Pratt's reply to M. Delaunay, which appears, by some error on the part of the author, to have been inadvertently sent, in the first instance, to the *Philosophical Magazine*, in which it appeared in *July* last.—EDIT. GEOL. MAG.

[2] Translated in the GEOLOGICAL MAGAZINE, November, 1868, Vol. V., p. 507.

surfaces gradually generates a rotary motion in the nucleus; and suppose this force to vary as the difference between the angular velocities of the crust and nucleus—that is, of the surfaces in contact. Let ω and ω' be the angular velocities at the time t, k and k' the radii of gyration of the two bodies, $\mathrm{F}(\omega-\omega')$ the force at the equator of the nucleus which represents the friction between it and the crust. Then the equations of motion are

$$\frac{d\omega}{dt}=-\frac{\mathrm{F}b}{\mathrm{C}k^2}(\omega-\omega'),\quad \frac{d\omega'}{dt}=\frac{\mathrm{F}b}{\mathrm{N}k'^2}(\omega-\omega')\quad .\ .\ .\quad (1)$$

Suppose also that β would have been the angular velocity, when the primitive impulse was given, on the hypothesis of the crust and nucleus being rigidly connected so as to be one mass. Then

$$\beta(\mathrm{C}k^2+\mathrm{N}k'^2)=\alpha\mathrm{C}k^2\ .\ .\ .\ .\ .\ .\quad (2)$$

Subtracting the second of equations (1) from the first, putting

$$\mathrm{F}b\left(\frac{1}{\mathrm{C}k^2}+\frac{1}{\mathrm{N}k'^2}\right)=c,\ .\ .\ .\ .\ .\ .\quad (3)$$

and integrating, we have

$$\omega-\omega'=\text{const.}\times e^{-ct}.$$

When $t=0$, $\omega=\alpha$ and $\omega'=0$;

$$\therefore\ \omega-\omega'=\alpha e^{-ct}.$$

Hence, by the first of equations (1),

$$\frac{d\omega}{dt}=-\frac{\mathrm{F}b\alpha}{\mathrm{C}k^2}e^{-ct}=-\frac{\mathrm{N}k'^2c\alpha}{\mathrm{C}k^2+\mathrm{N}k'^2}e^{-ct},\text{ by (3)};$$

$$\therefore\ \omega=\alpha-\frac{\mathrm{N}k'^2}{\mathrm{C}k^2+\mathrm{N}k'^2}\alpha(1-e^{-ct});$$

and also

$$=\beta\left(1+\frac{\mathrm{N}k'^2}{\mathrm{C}k^2}e^{-ct}\right),\text{ by (2)}.$$

The first of these expressions shows that the angular velocity of the crust begins with α; and when ct becomes very large indeed, it is reduced to β. Hence the effect of the constant friction of the nucleus against the inner surface of the crust is *at last* to reduce the velocity of the crust to what it would have been at first if the crust and nucleus had been one solid mass.

We may conclude perhaps that the same effect would be produced, though in a much longer time, if the interior were not a solid sphere, but a fluid mass.

The above reasoning shows that if the disturbing force producing precession and nutation did not exist, and the interior of the earth were fluid (whatever the thickness of the crust), it may be fairly assumed that the motion of rotation of the crust would *now*, the earth having existed so many ages, be exactly what it would have been had the earth been one solid mass, all difference of motion having been long ago annihilated by the internal friction and viscidity.

4. But the disturbing force producing precession and nutation does exist. It consists of two parts, one constant and the other variable and periodical. The constant part is that which produces the steady precession of the axis (and which I call for convenience the precessional force); the other produces the nutation. I will consider the precession first. Suppose now, for the sake of argument, that at the present moment, as M. Delaunay imagines, the crust and the fluid are revolving precisely as one mass, all previous differences of motion, even under the action of the disturbing force which produces precession and nutation, having been annihilated by friction and viscidity. I ask, what will be the action of the precessional force from this moment? It tends to draw the pole of the crust towards the pole of the ecliptic: and this tendency, as mathematical physicists well understand, combined with the rotary motion of the crust, produces this singular result, viz., the pole does not move towards the pole of the ecliptic, but shifts in a direction at *right angles* to the line joining the poles towards the west; so that the inclination of the axis to the ecliptic remains constant, but the axis shifts towards the west. The space through which it shifts in an infinitesimal portion of time varies as the length of the time and the force directly, and as the inertia of the mass to be moved inversely. The inertia of the mass depends upon the thickness of the crust only; for the friction of the fluid against the inner surface of the crust (which might, as I have shown, in the course of years produce a sensible effect) cannot do so during the infinitesimal portion of time I am considering before the precession is actually produced. The precessional force has its full effect in producing the precession of the solid crust, the fluid not having time to diminish that effect before the axis has assumed a new position; and in this new position of the axis the precessional force is precisely the same in amount as before, to go on causing the precession as before. The precessional force, is in fact, ever alive and active, and shows this in incessantly producing the effect I have described; and the precession goes on steadily, the amount of it depending upon the mass of the crust thus moved, which the fluid has not time to retard or lessen. M. Delaunay says that "the additional motion due to the above-mentioned cause [the disturbing forces which give rise to precession and nutation] is of such slowness, that the fluid mass which constitutes the interior of the globe must follow along with the crust which confines it, exactly as if the whole formed one solid mass throughout." In reply to this I say that it is not the slowness of the motion, but the want of solid connection between the crust and the fluid in contact with it which affects the problem. The motion, whatever its amount, is incessantly being generated by the disturbing force; and owing to this want of solid connexion, the friction of the fluid has not time during the successive moments during which the precession is generated, to stop or even sensibly to check it.

It will thus be seen that at every instant the precessional force proceeding from the action of the sun and moon on the protuberant part of the earth's mass will, if the earth be a solid mass, have to move the whole mass; and if the earth have a solid crust only, with a fluid interior, the force will have to move only the crust, against the evanescent resistance of the fluid within during so short a space of time as it takes to produce precession. The resulting precessional motion will be different in the two cases; and therefore the actual amount of the precession which the earth's axis has (and which is a matter of observation) is a good test of the solidity or fluidity of the interior. This is Mr. Hopkins's method.

The force producing nutation is much smaller, even at its maximum, than the precessional force. Its effect, however, is precisely the same in this respect—that it depends upon the mass of the solid crust, and in no respect upon the friction of the fluid within it, which has not time to influence the nutation before the nutation is actually produced.

5. I do not here undertake to go into Mr. Hopkins's numerical calculations; I simply vindicate his method. I do not here consider what modification the elasticity of the solid materal of the earth may have upon his numerical results. I conceive that it would have no effect, if the disturbing force were constant and there were no nutation. For under the dragging influence (if I may so call it) of the constant precessional force, the solid material would be under a steady strain, and would communicate the effect of the force, continuously acting, from particle to particle of the solid part as if it were really rigid; and the resulting precessional motion would be greater or less as the mass of the solid part may be smaller or larger—that is, the solid crust thinner or thicker. But as the disturbing force is not constant, but variable, and there is constantly nutation of the axis as well as precession, the action above described will be somewhat modified; and the elasticity of the solid material may be expected to have some influence on the result. This influence, however, will be minute, as the part of the disturbing force which is variable and produces nutation is very much smaller, even at its maximum, than the precessional force. The consideration of this matter, however, has no bearing upon the validity or not of Mr. Hopkins's method, but simply upon the numerical value of his final result, not upon the question of the fluidity or solidity of the earth's mass.

6. It will appear then, I, think to your readers that the strictures of M. Delaunay upon this method, which the genius of Mr. Hopkins devised, betray an oversight of the real point upon which the success of his method depends, and that this method stands unimpaired.

NOTICES OF MEMOIRS.

I.—On the Discovery of a Fossil Snake, *Python Euboicus*, Roemer, in the Tertiary Calcareous Slates of the Brown-coal formation of Kumi, in the Island of Eubœa. By Herr Ferd. Roemer, of Breslau.

[Abdruck a. d. Zeitschr. d. Deutschen geologischen Gesellschaft, Jahrg. 1870.]

FOSSIL snakes are exceedingly rare remains. Prof. Owen has described four species of *Palæophis* and two species of

Paleryx, from the London Clay, Middle and Lower Eocene of England,[1] and the remains of a serpent *Laophis crotaloides*, Ag. discovered by Capt. Spratt, R.N., in a Tertiary formation at Salonica.[2] We noticed the discovery, by Prof. O. C. Marsh, of Yale College, Ct., U.S., of a new gigantic fossil serpent, *Dinophis grandis*, from the Tertiary of New Jersey, last month (p. 377).

The description, therefore, of a comparatively well preserved, and clearly identified ophidian, from the Tertiary limestone (Kalkschiefer) of Kumi, in the Island of Eubœa, by Prof. Roemer, of Breslau, is so important as to merit the attention of palæontologists.

The remains were found in a slab of limestone, 9in. in length by 5in. in breadth, which exhibits on its surface the vertebral column and ribs of an ophidian.

It was procured for the University Museum from the cabinet of the late Dr. Beinert, and is stated to have been obtained from the wall of the Brown-coal deposit of Kumi, and is probably of Miocene Tertiary Age, like those from the Braunkohlen formation of Germany.

The portion of the skeleton preserved consists of part of the vertebral column, 9½in. in length, and comprising 25 vertebræ with the ribs attached, also the greater part of the left ramus of the lower jaw, with eight of the teeth *in situ*. The specimen is so disposed upon the slab that about half the vertebræ exhibit their dorsal, and half their ventral, aspect.

The vertebræ of the fossil snake correspond, in all important respects, with those of the living *Python*. When compared with those of *Python bivittatus* the dorsal processes are somewhat less pronounced, and the antero-lateral faces are somewhat produced. The form also of the vertebræ enabled the author to determine to what portion of the column of the snake these bones belonged. The vertebræ of the anterior part of the back-bone of the living *Python* are provided with processes (*hypapophyses*), directed obliquely downwards and backwards, the length of which is equal to, or exceeds, the diameter of the body of the vertebra. The remaining vertebræ, down to the caudal series, do not possess these inferior processes. In place of this they are provided with a small rounded protuberance, in which the ventral ridge terminates at the hinder end. Prof. Roemer detached the two most anterior vertebræ of the fossil *Python*, but found no hypapophyses under them, but a small rounded prominence like that observed in the dorsal series of the living *Python*. This shows that the fossil vertebræ in question belong to the middle part of the trunk. The uniformity of the size of the vertebræ also proves them to be from the central portion; for anteriorly and posteriorly they diminish in the living *Pythons* and *Boas*.

The ribs are only partially preserved, but 16 of the right side remain *in situ*; they are sabre-like in form, and correspond with those of the recent *P. bivittatus* already referred to. They are expanded at the proximal end, and are provided with an articulating face by which they are united to the corresponding articulating face of the protuberance (Diapophysial tubercle, Owen) on the side of the vertebral body. The thinnest part of the rib is at five-sixths of the entire length, and the last sixth becomes broader, and terminates bluntly.

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[1] Pal. Soc. Lond. Mon. Ophidia, 1849–50.

[2] Quart. Journ. Geol. Soc., Lond., vol. xiii., 1857, p. 196.

It is interesting to find that in Miocene times various large tropical snakes had their habitat in Greece, and it adds another fact to M. Gaudry's interesting discoveries of a tropical mammalian fauna in this ancient continent, of which but so small a part now remains.

II.—NEW AMERICAN REPTILIA.[1]

By Prof. J. D. COPE.

THE fossil which Prof. Cope exhibited was the almost perfect cranium of a Mosasauroid reptile, the *Clidastes propython*. He explained various peculiarities of its structure, as the moveable articulation of certain of the mandibular pieces on each other, the suspension of the os-quadratum at the extremity of a cylinder composed of the opisthotic, etc., and other peculiarities. He also explained from specimens, the characters of a large new Plesiosauroid from Kansas, discovered by Wm. E. Webb, of Topeka, which possessed deeply biconcave vertebræ, and anchylosed neural arches, with the zygapophyses directed after the manner usual among vertebrates. The former was thus shown to belong to the true Sauropterygia, and not to the Streptosauria, of which *Elasmosaurus* was type. Several distal caudals were anchylosed, without chevron bones, and of depressed form, while proximal caudals had anchylosed diapophyses and distinct chevron bones. The form was regarded as new, and called *Polycotylus latipinnis*, from the great relative stoutness of the paddle.

Prof. Cope also gave an account of the discovery, by Dr. Samuel Lockwood, of Keyport, of a fragment of a large Dinasaur, in the clay which underlies immediately the marls below the lower green sand bed in Monmouth County, New Jersey. The piece was the extremities of the tibia and fibula, with astragalo-calcaneum anchylosed to the former, in length about sixteen inches; distal width fourteen. The confluence of the first series of tarsal bones with each other, and with the tibia, he regarded as a most interesting peculiarity, and one only met with elsewhere in the reptile *Compsognathus* and in birds. He therefore referred the animal to the order *Symphypoda*, near to *Compsognathus* Wagn. The extremity of the fibula was free from, and received into, a cavity of the astragalo-calcaneum, and demonstrated what the author had already asserted, that the fibula of *Iguanodon* and *Hadrosaurus* had been inverted by their describers. The medullary cavity was filled with open cancellous tissue. The species, which was one half larger than the type specimen of *Hadrosaurus Foulkii*, he named *Ornithotarsus immanis*.

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[1] Proceedings American Phil. Soc., Vol. XI., p. 117.

III.—NOTICE OF A NEW SPECIES OF GAVIAL FROM THE EOCENE OF NEW JERSEY, U.S.

By Prof. O. C. MARSH, of Yale College, Ct.[1]

SOME interesting reptilian remains have recently been obtained from the Eocene Greensand of Shark River, Monmouth County, New Jersey, indicative of a new species of Gavial, considerably smaller than any crocodilian heretofore discovered. They were found together, and are evidently parts of the same skeleton. They consist of various fragments of the skull, and ten vertebræ. The coössification of the neural arches of the vertebræ, and the almost entire obliteration of the sutures in some of them would imply that the individual, although diminutive, was nearly or quite mature.

The portions of the skull preserved indicate that the animal had an elongated muzzle, and that the upper posterior parts of the skull were of the gavial type. The temporal apertures were large and near together. The teeth were not obtained.

The vertebræ are well preserved, and present marked characters. The articular cup is transversely oval in the cervicals and anterior dorsals, and has its upper margin depressed in the posterior dorsals. The hypapophyses are simple and elongate. The neural canal of the cervical and anterior dorsal series is transverse and sub-rectangular in outline, and the floor unusually broad and flat. In the posterior dorsals, the canal, although still transverse, becomes less rectangular, with the broader portion above.

The species may prove to be generically identical with the one named by the writer *Thecachampsa Squankensis*, which is the only crocodilian hitherto found in the Eocene of New Jersey.

The genus *Thecachampsa*, however, as proposed by Prof. Cope, cannot yet be regarded as a valid one, since the concentric structure of the dentine on which it was founded[2] is not a character of generic importance; for it occurs in various other crocodilians, and also in some Cetacea. The present remains are therefore provisionally placed in the genus *Gavialis* and the species called *G. minor*. The animal to which these remains belonged was quite slender and about six feet in length.

IV.—RECORDS OF THE GEOLOGICAL SURVEY OF INDIA. Vol. iii., Part 2. MAY, 1870.

The Contents of this number of the "Records" are—

1. *Geology of Gwalior and its vicinity.* By C. A. HACKET.

THE area described is a low hilly district, comprising some alluvium. Crystalline rocks occupy a narrow strip of country, which is also traversed by numerous large quartz veins. But the more prominent rocks of the area belong to the Gwalior Series and the Upper Vindhyan. These two series are unconformable to each other, the former having been immensely denuded before the deposition of the latter.

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[1] From American Journal Science, Second Series, vol. l., no. 148, p. 97.

[2] Proceedings Philadelphia Acad. Nat. Sciences, 1867, p. 143.

The Gwalior Series is composed of quartzite, sandstone, limestone, jasper, and contemporaneous trap. It is divided into two groups—the Par, and above it the Morar Group. Diorite is the form of trap which occurs in these beds, a variety in which the separate crystals of hornblende and felspar are visible to the naked eye. Magnetic iron is found in it.

The Vindhyan rocks occurring in the area were described by Mr. Mallet (see GEOLOGICAL MAGAZINE, April, 1870, p. 171). Their age was pointed out as very uncertain, possibly Devonian. No conclusion can be drawn as to the exact place of the Gwalior Series in the Indian scale.

2. *Note on the Slates at Chiteli, Kumaon.* By THEODORE W. H. HUGHES, F.G.S.—The author having been requested to report on the suitability of the slates for roofing purposes, accordingly visited the locality, where an experimental quarry had been opened. The slates dip at high angles, but they are not cleaved in a definite manner. Their general quality bears favourable comparison with other Indian specimens; but it is below the standard of typical Welsh slate. It differs from the latter in splitting along the planes of lamination, instead of the planes of cleavage. It is coarser in texture, and more siliceous. The slate is good enough for roofing purposes, it well withstands the action of the weather, and slabs less than a quarter of an inch in thickness, and much more than a square foot, superficial measurement, may be easily obtained.

3. *Note on the Lead Vein near Chicoli, Raipur District.* By W. T. BLANFORD, F.G.S.—The ore (galena) occurs in a well-marked vein, chiefly composed of quartz, which traverses the metamorphic rocks. The vein also contains pink felspar, green and purple fluorspar. Slight but unmistakeable indications of the presence of copper were found. The width of the vein varies greatly; sometimes it is six feet, at others, nearly 30 feet. Altogether, Mr. Blanford thinks there is nothing in the appearances presented by the Chicoli Lode, inconsistent with the occurrence of a good vein of lead and copper ore below the surface. He adds, that it is the first instance of a distinct metallic Lode he has seen in India.

4. *The Wardha River Coal-fields, Berar and Central Provinces.* By Dr. OLDHAM, F.R.S., etc.—These coal-fields have been previously noticed in the "Records," Vol. ii., Part 4, p. 94, but since that time great progress has been made in the detailed exploration of the field.

Thick beds of coal had been observed in the banks of the river Wardha, but their continuance inland could not be traced, owing mainly to thick coverings of clays. It was found necessary to make borings, the results of a few were given in the previous report; records of the other borings, and the general results are now given. The inland extension of the coal-beds has been proved in many places, and their great and sudden variation in character is markedly indicated. In Wun district, to the West of Wardha, there is estimated to be about 70 square miles of country under which the thick coal may fairly be presumed to extend, and probably nowhere will it be found at a greater depth than 120 yards below the surface. The average thickness of coal established by the numerous trials may be taken as nearly 40 feet, but this includes some beds that would not be worth working, and probably 20 feet would represent the maximum thickness of workable coal. Taking these data, and making allowance for faults and disturbances, Dr. Oldham calculates that there is an available quantity of coal in East Berar equal to about 480,000,000 tons.

Passing into Chanda, the small area occupied by coal, precisely the same as that in Berar, would probably yield about 78,000,000 tons of workable coal.

5. *Report on the Coal at Korba, in the Bilaspur District.* By W. T. Blanford, F.G.S.—The coal is exposed in two places in the bed of the Hasdo river, just below Korba. The thickness was estimated, though roughly, from its dip and length of outcrop, to be at least 90 feet, including bands of shale and inferior coal. In order to obtain a more correct idea of the quality of the coal, small pits were dug, these proved a minimum thickness of 50 feet of fair coal. Mr. Blanford points out the best places for borings in order to ascertain the extent of the seam, as sufficient data are not known to justify the opening of a coal mine. Both the quality and mode of occurrence of the coal are considered favourable, and indeed, to surpass that near Chanda.

REVIEWS.

I.—Report of the Rugby School Natural History Society for the Year, 1869. Rugby: W. Billington, 1870, pp. 59.

We have already called attention to the activity of this useful Society. The third report now issued shows it to have lost none of its vigour. Throughout the academical year meetings have been held each fortnight, and masters and scholars alike have contributed, by papers and presentations, or exhibitions of natural history specimens or apparatus, to render them very interesting. Of the many papers read but a few are printed. They suffice to show, however, that the salient features of recent scientific discovery are with little delay laid before the members, and not a few report the results of individual observation. Among these is a valuable paper by Mr. J. M. Wilson, on the Drifts, Gravels, and Alluvial Soils of Rugby and its neighbourhood, describing some borings which he caused to be made, and the specimens obtained from them which he has deposited in the Arnold Library. "English Snakes and the Blindworm" is the title of a contribution by Mr. N. Masterman that is well worth reading. The author has studied the lives and habits of his pets, and speaks of them with an enthusiasm which is quite delightful. The botany of the neighbourhood has not been neglected, new localities are registered, and the variations in dates of flowering recorded. The mention of three other papers will suffice to show that the whole domain of physical science engages the attention of the Society. Mr. Wilson sends a paper on "A Remarkable Instance of Protective Mimicry among the Lepidoptera," that of *Papilio Merope* and *Danais Niavius*, which is provided with an excellent illustration. Mr. Hutchinson contributed one on "Spectrum Analysis and what it has done;" and Mr. Sedgwick an excellent chatty paper on "Norway."

The average attendance of members for the whole year is 39, and the list of presentation of books and specimens quite a large one. The Society is to be congratulated on what it has done, and we wish it continued success.

II.—Geology of the Country between Liverpool and Southport.

By C. E. De Rance, F.G.S.

One of the more recent publications of the Geological Survey of England is a short explanation accompanying sheet 90, SE. of the country between Liverpool and Southport. The greater portion of the area comprised in this sheet is covered by the sea. On the smaller portion of land the following deposits are described as occurring:—

Recent	Blown Sand Upper "Cyclas" Clay Upper "Scrobicularia" Clay.	Alluvium.
Pre-historic	Upper Peat. Lower "Cyclas" Clay.	
Post-glacial	Shirdley Hill Sand. Lower Peat.	
Glacial	Sand (Middle Drift). Lower Boulder Clay.	
Keuper	Keuper Marls. Lower Keuper Sandstone.	
Bunter	Upper Red and Mottled Sandstone. Pebble Beds.	

The Triassic beds play a very inconspicuous part in the Surface-geology of this district, "with the exception of the crests of two or three slopes" the area is deeply covered with drifts of various ages.

The Boulder-Clay is described as generally of a light-red colour, containing many small pebbles and occasional boulders, beds of marl, and seams of sand. The pebbles and boulders are almost exclusively erratic, Triassic rocks being rare.

Thin beds of sand occur at several places within the district, they are doubtfully referred by Mr. De Rance to the Middle Drift (now termed "Middle Glacial" by Mr. S. V. Wood, Jun.); they may, he thinks, be merely intercalated beds of sand in the Lower Boulder Clay.

Upon the "Lower Peat," which varies from one inch to four feet in thickness, the "Shirdley Hill Sand" generally rests. This is a light-coloured coarse sand, with occasional pebbles of quartz, and rarely the marine shells *Cardium edule* and *Turritella communis*. The range of low hills, the author remarks, which are composed of this nd, has much the appearance of a line of old Sand Dunes, formed the edge of a sea-margin.

The "Lower Cyclas Clay," containing *Cyclas cornea*, appears to a lacustrine deposit.

The "Upper Peat" has an average thickness of 12 feet, it contains soft blue silty clay, from which petroleum has been obtained.

The Alluvial Clays contain *Scrobicularia piperata* abundantly in me places, and *Cyclas cornea* in others.

REPORTS AND PROCEEDINGS.

THE MICROSCOPICAL EXAMINATION OF ROCKS AND MINERALS.[1]

By SAMUEL ALLPORT, F.G.S.

THE application of the microscope to Geology is a subject which has, I believe, been more generally neglected by men of science an any other of equal importance, although it is easy to show that is method of examination affords the readiest means of obtaining nformation on many important points, and is, in fact, the only way f ascertaining with certainty the composition of many compact or ine-grained rocks.

A valuable paper by Mr. Sorby, "On the Microscopical Structure f Crystals,"[2] and another by Mr. David Forbes, "On the Microsope in Geology," in the "Popular Science Review,"[3] constitute, I elieve, the extent of the published information on the subject. No ranch of science presents a more promising field of inquiry, for the omenclature and classification of igneous rocks is in a lamentable tate of confusion, and unfortunately the maps of the Geological urvey of England and Wales tend rather to increase the difficulty, y the indiscriminate use of terms not very definite in themselves.

It is evident that no satisfactory classification of rocks can be ade till their mineral constituents are accurately ascertained; and n the case of fine-grained or compact rocks, this cannot be done ither by chemical analysis or other ordinary methods of observaion. In such cases, various expedients have been adopted, but only pproximative results were obtained, and that they were altogether nsatisfactory will be evident from the following remarks of Bischof.[4] "It appears," he says, "to be quite in vain to attempt a classification f Greenstones; they constitute a series, the extreme numbers of which are, on the one hand, Augitic Porphyry, or Melaphyr, with istinguishable Augite, and Labradorite; and, on the other, Diorite r Syenite, with distinguishable Hornblende. Between these opposite xtremes there are many intermediate varieties, with regard to which it is quite uncertain whether they are to be classed with augitic or hornblendic rocks." Again, Cotta[5] describes Aphanite as "Trap in part, Melaphyr in part, a compact apparently homogeneous mass. The separate ingredients of this rock are not to be recognized by the naked eye, hence the name Aphanite given by Haüy. The minuteness and intimate union of the ingredients of Aphanite when quite compact make it impossible with the ordinary aids to discover whether it belongs to Diabase, Gabbro, or Diorite." Now it appears to me that to call a rock Aphanite, or to say that a classification of Greenstones is impossible, is just as absurd as it would be for a Zoologist or Botanist to assert that no satisfactory account could be given of animal or vegetable tissues because they cannot be made out by the naked eye or a pocket lens. The examination of many rocks, if not too fine grained, may be facilitated by examining a polished surface with a low power, or even by simply wetting the freshly-broken surface instead of polishing; but in the case of basaltic and other fine-grained rocks it is necessary to prepare thin sections for examination by transmitted light. This method is, in fact, by far the most satisfactory in the majority of cases, for not only may the various constituent minerals be readily observed, but the order in which they crystallized out from the mass, the changes which they have frequently undergone during the long lapse of ages, and other important facts, may also be thus ascertained.

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[1] Proceedings of the Birmingham Natural History and Microscopical Society.

[2] Quart. Journ. Geol. Soc., vol. xiv.

[3] Vol. vi., p. 355

[4] "Chemical Geology," vol. iii., p. 309.

[5] "Rocks Classified," p. 157.

A microscopical examination of rocks shows that, as a rule, the igneous rocks may be distinguished at once from all others by their structure, which is that of a more or less perfect network of minute crystals: in many cases all the minerals are well crystallized; in others there is an amorphous or glassy base in which they are enclosed; there are, however, other rocks, such as the Felstones and the more recent volcanic Phonolites, some of which do not present this crystallized arrangement of their constituents; and then there are the Porphyrites, which are characterized by the presence of crystals of felspar in a compact felspathic base. There is in fact a gradual passage from the compact Felstones to the Porphyrites, so that it appears probable that the amorphous base of all such rocks is simply the siliceous magma or paste from which distinct minerals would have separated had the circumstances under which they were formed been favourable for crystallization to have taken place. As a typical example of a widely distributed class of rocks, I will take for description the well-known basaltic rock of the Rowley Hills. An examination of thin sections shows that it contains a triclinic felspar, augite, magnetic oxide of iron, a little olivine, and a few crystals of apatite. The felspar is known to belong to the triclinic system, as it exhibits the characteristic striæ when examined by polarized light. Augite occurs in minute black shining crystals, which appear bright brown, or occasionally green when in thin sections: it cannot be mistaken for any other mineral except hornblende, from which it is distinguished by a marked difference in the angles; it has also a clear glassy appearance, while hornblende is either distinctly fibrous in texture, or exhibits lines or cracks running parallel with the principal cleavage plane. Very frequently hornblende is green, while augite is yellowish brown, but this does not always hold good. The magnetite occurs in minute grains, or as thin laminæ, both being black and opaque. The apatite is seen in long, acicular, hexagonal crystals. The olivine occurs in crystals, and also in irregular grains, of a clear yellowish green colour; it is, however, rare in this state, being nearly always altered to a dull dark green mineral. In addition to the above minerals, which must be regarded as the original constituents of the rock, there are also one or two zeolites, calcite, and a chloritic mineral, all of which are found filling cavities, and are secondary formations.

The use of the microscope is by no means confined to the discrimination of minerals; with its assistance we may learn many facts, as to the mode of formation of rocks, the order in which the various minerals crystallized, and the alterations which have been frequently caused by the removal of mineral matter, and its replacement by another of different chemical composition. In the Rowley rocks, the minute crystals of apatite penetrate both the felspar and augite; the latter also encloses crystals of felspar and magnetite; the augite crystallized therefore, after the others had been formed. The olivine contains grains of magnetite only, and was probably the second to crystallize.

Cases are not uncommon in which crystals have caught up portions of the surrounding mass while in the act of formation, and other facts indicate very clearly the actual condition of the mass at the moment of crystallization. For example, in a section of Pitchstone from Planitz, containing crystals of felspar, the minute opaque particles thickly scattered through the matrix are crowded together round the sides of the crystals, having been forced outwards as the latter increased in size; this clearly indicates that during the formation of the crystals, the matrix was in a *viscid*, but not in a *fluid* state, for had the particles been quite free to move, there would have been no crowding.

In a section of basalt from the Rhine, the olivine is in its usual fractured condition, and some of the larger cracks have been filled up with the fine crystallized matrix in which they are imbedded; there is no crowding of the particles; in this case, therefore, the olivine was not only crystallized, but fractured before the consolidation of the mass. In another section of basalt the crystals of augite and olivine are somewhat rounded, and the cracks filled up, so that they probably existed as crystals or grains before the ejection of the lava.

One of the most important aids in the examination of rocks and minerals is afforded by polarized light. In many cases it enables us at once to discriminate between different minerals, and not unfrequently affords clear evidence of changes which have taken place subsequently to the consolidation of the substance under examination. When a thin section of a crystal is placed on the stage of the microscope, and a beam of polarized light passed through it, the beam is depolarized, and generally exhibits colours due to interference; the intensity of colour varies according to the direction in which the crystal is cut, and consequently in examining a section of rock, the various sections of any one mineral do not always give the same result; but as the crystals of igneous rocks lie at all angles, it is nearly always easy to obtain some, which, being cut at an inclination to the optic axis, exhibit different degrees of intensity of action; therefore minerals which vary much from each other in this respect may be easily distinguished.

A most important point to be noted is, that the depolarized action of a crystal is uniform over the whole surface of its section if it consists of one simple crystalline structure; when, however, the light appears to break up into detached parts, each of which changes independently as the analyzer is rotated, we know that it is made up of a number of separate crystalline portions, either independent of each other, or sometimes related as twins.[1]

A knowledge of these facts enabled me to detect the presence of olivine and its pseudomorphs in the Rowley rock, as described in a former paper, and also in the GEOLOGICAL MAGAZINE, Vol. VI., p. 115. A pseudomorph is a mineral possessing a crystalline form, which does not belong to the substance of which it is composed; it is an altered mineral, or in other words, an aggregate of mineral matter, which has been deposited simultaneously with the removal of that which possessed the original crystalline form; it is easy, therefore, to see that the molecular arrangement of the particles must be entirely different from that of the original crystal. Now by the aid of polarized light, such changes are at once rendered apparent; and we thus possess the means of obtaining most important information on the metamorphism of rocks and minerals, of which ordinary light would afford no indication whatever.

Serpentine has hitherto been a great puzzle to geologists, some having regarded it as an intrusive igneous rock, others as of metamorphic origin. As not unfrequently happens, both are, I believe, right, for every section I have made clearly proves it to be an altered rock, and one specimen from the Vosges mountains contains numerous grains of olivine, in which the change is only partially developed.

These few facts will serve to indicate the importance of this hitherto neglected method of inquiry; for although the pseudomorphism of many minerals has been long studied, little attention has been directed to similar changes in rock masses.

A subject of interest to the microscopical observer, and one of considerable importance to the petrologist, is the occurrence of minute fluid cavities in the minerals of igneous and metamorphic rocks. They have been detected in several minerals ejected from active volcanos; but so far as I have observed, they are far more abundant in quartz than in any other mineral. Those who wish to examine them may do so by making a section of almost any specimen of granite. They are very numerous in the granites and schorl rocks of Cornwall, the hornblendic granite of Mount Sorrel, in the syenite and gneissoid rocks of Malvern, and in the syenite of Croft Hill, and neighbouring bosses in Leicestershire. In these and similar rocks, the fluid cavities appear to be so entirely restricted to the quartz that I have not yet detected any in the felspar or mica; they are certainly extremely rare in these minerals, if they occur at all. This, if established, would indicate a difference in the condition under which the minerals were formed, a point which I believe has not yet received attention.

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[1] Sorby "On Examination of Rocks and Minerals" in Dr. Beal's Work on the Microscope.

For an account of the curious spontaneous movements of the fluid in some of these cavities, and for other interesting matter connected with the subject, I must refer you to Mr. Sorby's paper already quoted.

During the past summer and autumn (1867) I have collected specimens of the igneous rocks of the Midland coalfields from the following localities:—Kinlet and Shatterford, west of Kidderminster; the Clee Hills, Little Wenlock, near the Wrekin, in Shropshire; Coalville near Bardon Hill, in Leicestershire; and Matlock, in Derbyshire.

A microscopical examination of thin sections shows that all these rocks belong to the same type; they do not differ more from each other than do different specimens of any one of them. The toadstone of Derbyshire is merely an amygdaloidal variety.

The rocks of the Warwickshire coal-field differ considerably from the foregoing. They contain hornblende instead of augite, and are, therefore, true greenstones or diorites. They may be readily examined in the railway cutting near Nuneaton, and also a little to the west of Atherstone. All the rocks just enumerated are clearly older than the surrounding Permians, which are never penetrated by them.

Having now made upwards of four hundred sections of rocks and minerals, I am inclined to believe that the following results of microscopical examination will stand the test of further study:—

1. The mineral constituents of the melaphyres and other fine-grained igneous rocks may be determined with certainty, a result which has not been attained by any other method of examination.
2. The mineral constituents of the true volcanic rocks, and those of the old melaphyres, are generally the same.
3. The old rocks have almost invariably undergone a considerable amount of alteration, and this change alone constitutes the difference now existing between them and the more recent volcanic basalts.

The basaltic lavas of the Rhine and Central France are composed of a triclinic felspar, augite, magnetite, olivine, and frequently apatite; the same minerals as those constituting the old rocks above described. I have fine-grained specimens of the latter hardly distinguishable from recent basalts; and a section of dolerite from the Puy de Barnère, in Auvergne, does not differ in any important particular from coarse-grained specimens from Rowley.

It would be easy to extend the parallelism to other classes of rocks, but I will now only observe that we have here another proof of the doctrine long taught by Lyell—the uniformity and continuity of the laws of Nature.

GEOLOGICAL SOCIETY OF LONDON.—*Concluded from the August Number, p.* 394.—June 22nd, 1870.—"On the Physics of Arctic Ice as explanatory of the Glacial Remains in Scotland." By Dr. Robert Brown, F.R.G.S., etc. Communicated by Professor Ramsay, F.R.S., F.G.S.

In this paper the author entered into an extended inquiry how far the formation of the Boulder-clays and other glacial remains in Scotland and the North of England can be accounted for, on the theory of a great ice-covering having at one time overlain the country in much the same manner as it now does Greenland and other extreme Arctic countries. Taking the hypothesis of Agassiz as his groundwork, Dr. Brown entered into a minute description of the present glacier-system of Greenland, and the nature of Arctic ice-action; and into an inquiry how far glacial remains in Britain correspond with those at present in course of formation in Greenland, and at the bottom of Baffins Bay, Davis's Straits, and the Fjords and bays adjoining these seas. These inquiries were commenced in the year 1861, and have been continued at intervals ever since up to the present summer in various portions of the Arctic regions, the Continent of Europe, in Great Britain, and in North America across to the Pacific. The results of these extended researches have led him to conclude—1. That the subazoic boulder-clay corresponds with the *moraine profonde* which underlies glaciers, and in all likelihood is the immediate base on which the ice-cap of Greenland rests. 2. That the fossiliferous, laminated, or brick-clays find their counterpart in the thick impalpable mud which the sub-glacial streams are pouring into the sea, filling up the Fjords, even shoaling the sea far out, and absolutely in some cases turning the glaciers from their course into other valleys. Allowing the very moderate computation that this impalpable mud accumulates at the rate of only 6 inches per annum, a deposit of fifty feet in a century must form.

If Scotland was at one time covered with. an ice-cap, or had glaciers of any extent (as cannot be doubted), then this deposit must have been equally forming, and, as a geological formation, must be accounted for. No difference could be detected between this glacial mud and the present brick-clays, and every fact went to show that it was to this source we must look for the formation of these laminated fossiliferous clays. The amount of earth deposited on the bottom by icebergs was very insignificant indeed, and could in no degree account for the *boulder-clay*, though it was shown that much of the *boulder-drift* in *some places* could be so accounted for. It was, however, demonstrated that there was a great distinction between the boulders which belonged to the *moraine profonde* and those which were carried off on icebergs as part of the ordinary lateral moraines.

The Fjords, as already partially advocated in a paper in the Journal of the Royal Geographical Society (vol. xxxix.), he considered due to glacier action, the glaciers having taken possession of these Fjords when they were mere valleys, and the coast was higher than now. He further showed that the American explorers are in error when they describe the coast of Greenland as rising to the north of 73°, and subsiding to the south of that parallel. There had been a former rise of the coast, and a fall was now in course of progress through the whole extent. Whether these had previously alternated with other rises and falls is not clearly evidenced by remains, but no doubt exists that a rise preceded the present subsidence. Numerous facts were adduced in support of this assertion. The remainder of Dr. Brown's paper was occupied in an attempt to apply the doctrines regarding the physical action of Arctic ice to account for the Scottish glacial remains, and to deduce therefrom evidence regarding the changes Scotland underwent during and subsequent to the glacial period.

Bath Natural History and Antiquarian Field-club.—The third excursion of the season was specially devoted to geology. Twelve members and two visitors started by the 8.25 a.m. train from the Midland Station for Longhope *viâ* Gloucester. The famous Longhope quarry, where the Ludlow beds of the Upper Silurian strata with olive-green micaceous shales were first seen dipping at a high angle beneath the New Red Marls, and left for exploration until the return to the station. The Secretary briefly pointed out that the members were standing on the line of a great fault, and that the whole mass of the Old Red Sandstone and Carboniferous series of the Forest of Dean ought to come in between the New Red Marls on which they were standing, and the quarry of Upper Ludlow close at their back. He also explained that owing to the great dip of the beds their walk would take them in the descending order across successively the Upper Ludlow beds, the Aymestry limestone (which appeared here to be represented by the more calcareous portion of the Ludlow beds), the Lower Ludlow, the Wenlock limestone and shales, to the base of the Upper Llandovery rocks of which May-hill was composed. Ascending the steep lane and reaching the top of the ridge, a fine section of Wenlock limestone is exposed with its associated shales, and on the refuse heaps various characteristic fossils were collected, *i. e.*, *Atrypa reticularis*, *Orthis elegantula*, *Rhynchonella* (*borealis*)? *Strophomena depressa*, *Cyathophyllum*, *Bryozoa*, etc. After lunch Mr. Symonds gave an eloquent *resumé* of the geology of the district. All had heard, he said, of the Laurentian rocks of Canada, the most ancient sedimentary stratra in the world. The equivalents of these had been found in the Isle of Lewis, on the west coast of Scotland, in Sutherland and Ross, and he believed they were now looking upon old Laurentian deposits in those metamorphosed rocks forming the Malvern range before them. Associated with these deposits were ancient lava beds traversing them as dykes, these being representatives of the oldest volcanic rocks in England. In these were apparent the cause of that metamorphism and disturbance so evident on all sides. On their flanks rested quartzites, which may be certain altered representatives of the Cambrian rocks, and along the South Malvern were the Lower Silurian rocks also here and there altered by the volcanic influences referred to. Allusion was here made to the result of Dr. Holl's labours in working out the geology and mineralogy of the Malvern rocks, and Mr. Symonds proceeded to describe how after the deposit of the Lower Silurians, and about the period of the Upper Lingula beds, there was an outburst of volcanic matter again along the line of the Malverns, which, as in Snowdonia, showered its ashes into the surrounding sea. In the Malvern country the site of the Llandeilo and Caradoc formations is occupied by trap, no Caradoc proper being found in this country. At this time was formed the columnar basalts near Eastnor, the result of a lava outpouring into a shallow sea. After this the base of the Upper Silurians, viz., the coarse and fine conglomerates of May-hill, which must then have been a sinking area, were formed from the disintegration of the rocks of the more ancient periods, and washings of a shallow sea.

Having thus brought the thoughts of the members to the strata on which they were standing, Mr. Symonds described the various changes, through earthquake and other volcanic agencies, in the height of the land which had taken place after the Permian period, and said that he had no doubt, were a tunnel cut through the hill, they would find the same nucleus of Gneissic beds beneath their feet as composed the Malvern range. The summit of May-hill was composed of the usual conglomerate which, so far as his experience extended, always composed the base of the Upper and the Lower Llandovery; at May-hill it was the base of the Upper Llandovery beds that they were standing on. Some idea of the elevation of the May-hill sandstone might be formed from the fact that all the rocks of the Upper Silurians of Ledbury, the Old Red Sandstone of Herefordshire, and probably the Carboniferous rocks of Dean Forest once overlay the beds beneath their feet. Crossing to the west side of the hill whence the Forest of Dean coal field could be seen, Mr. Symonds stated that the great dislocation which had caused the elevation of the strata on the west, and the downthrow on the east, had taken place during the Permian period, and in conclusion he drew attention to the vast amount of denudation which must have taken place, as most probably the Carboniferous limestone had formerly extended from the South Wales coal basin to the Clee hills in Shropshire. He also mentioned the detection, a few weeks ago, of the Haffield or (Permian) breccias, on the eastern flanks of May-hill, by himself and Mr. W. E. Price, of Tibberton Court, and that Mr. Price had since then found a fossil in one of the pebbles embedded in the breccia, which he hoped might give them some clue as to the age of the deposits from which the pebbles in the breccia were derived. An inspection of the quarries on the top of the hill was now made, and a most satisfactory confirmation of the theory that May-hill is composed of Llandovery rocks took place, some of the members being fortunate enough to discover in the coarse conglomerates which crop out on the top of the hill, several fossils, which Mr. Symonds at once identified as characteristic of the Llandovery formation, .*i.e*, *Pentamerus lævis* or *oblongus*, *Orthis calligramma*, *Tentaculites*, *etc.*

Richmond Naturalists' Field-club.[1]—An excursion was made by this excellent Club to Flamborough Head on the 21st of June, 1870, under the direction of Edward Wood, Esq., F.G.S., the esteemed President and founder of this Society.

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[1] From the Richmond and Ripon Chronicle, June 25th, 1870.

The main object of the Society has always been to develope an interest in Natural History, Geology, Botany, and the kindred sciences, and, with this object in view, excursions have been undertaken at different times—on some occasions on foot in the immediate neighbourhood, and at others by conveyances or by rail, to places interesting from their geological and botanical features.

This year it was arranged by Mr. Wood, F.G.S. (the President), to undertake a journey to Flamborough Head, a distance by rail of upwards of 100 miles, for a day's excursion. The undertaking was somewhat daring, as the time consumed in railway travelling was six hours each way, and necessarily abridged the hours to be devoted to the scenery of Flamborough. The arrangements made by Mr. Wood were, however, so complete, that, had it not been for a slight accident, the success of this excursion would have been unprecedented.

The 21st of June, the longest day being chosen, happening as it did to fit with the state of the tide, which is a point of some importance, arrangements had been made with the North-Eastern Railway Company for special carriages to be placed at the disposal of the members, who travelled *viâ* Malton and Seamer Junction. Accordingly the members, numbering upwards of eighty ladies and gentlemen, met at the Richmond Railway Station at 6.40, and proceeded on their journey. A halt took place at Thirsk, and another at Malton. At half-past twelve Bempton Station was reached, where a number of carriages were in waiting to convey the excursionists to Flamborough Head. A walk of great interest along the cliffs was the feature of the day's excursion, and the weather being exceptionally beautiful, the sea as smooth as glass, the sky clear of cloud, and a midsummer sun lighting up the scene gave additional interest to what, under any circumstances, might be described as one of the most magnificent coast scenes in England. This, the most Eastern part of the Chalk formation in England, is the most striking promontory on the coast, the cliffs at some points being upwards of 400 feet above high-water. The Chalk of Flamborough is remarkably rich, in fine silicified sponges (*Rhizospongia polymorpha* and the genera *Siphonia*, *Jærea*, *Eudea*, etc.) The walk along the grand and rugged cliffs, which here and there open into small bays with spires of rock of immense size and most grotesque forms, is most picturesque. Several halts were made, when the President pointed out the haunts of the sea-birds in the clefts of the rock. At the termination of the walk most of the party descended a ravine where boats were waiting to conduct them to the celebrated caves—the most striking of which—Robin Lyth's hole, is nearly 60 feet high, and approached by a very narrow entrance on the land side. Robin Lyth, a fierce pirate, is said to have made this cavern his stronghold.

After visiting the caves the party returned to the carriages, which were waiting a short distance off to convey them to Bridlington Quay; on the way there a delay took place from the upsetting of a waggonette in which were six or eight of the excursionists. Fortunately no serious injury was sustained by the occupants. The misfortune, however, so far interfered with the arrangements of the day, that the excursionists were unable to sit down to the dinner, to which they had been invited by the President at the Alexandra Hotel, until nearly half-past five, at which hour they ought to have been on their return journey. In consequence of the hurry the party were not able to do justice to the magnificent repast which had been prepared. The usual loyal toasts were obliged to be dispensed with, but the President said he could not let the opportunity pass without proposing the health of the Vicar of Bridlington, who had joined the excursionists and kindly acted as *Cicerone*. In proposing the toast, Mr. Wood mentioned the fact that the Rev. gentleman had earned a title to the gratitude of all naturalists from his exertions in originating and forwarding the measure, which had now become law, for the protection of sea-fowl. In returning thanks, the Rev. H. Barnes said that although he had taken great interest in the question, the thanks of the nation were equally due to his friend Mr. Harland. Mr. Armstrong, of Richmond, proposed the health of Mr. Wood, the President, and eulogised his exertions on behalf of the Naturalists' Club. The President replied in a few words, and the party then hurried off to the station to catch the train for Scarborough at six o'clock, when it was found that the station master had sent off the carriages without any occupants to Scarborough. In consequence of this the whole party were detained at Bridlington until eight o'clock, when they proceeded to Scarborough, from whence a special train was engaged by the President to take them to York, to meet the fast train for the north at 10.25. The party arrived safely in Richmond at midnight.

CORRESPONDENCE.

MR. DAVID FORBES'S LECTURE ON VOLCANOS.

SIR.—The able lecture of Mr. D. Forbes, on Volcanos, delivered in St. George's Hall, on the 19th June last, and printed in your July Number, contains views so nearly identical with my own upon this interesting branch of Geology, that I may be allowed, perhaps, without apparent presumption, to mention a very few points on which I am inclined to differ from the lecturer.

1. In his description of a volcanic eruption, p. 318, line 1, he ascribes the formation of the "Volcanic ash or dust," (which may be estimated to compose at least a moiety of the products of every considerable eruption, being carried away by winds, and spread often in layers of some depth, over enormous areas of sea and land) to "the *instantaneous* reduction to an almost impalpable powder" of liquid lava ejected by the gaseous explosions which constitute one of the main features of an eruption. Now my observations on the Vesuvian eruption of 1822 convinced me that the jets of lava thrown up by the great bursting bubbles of steam (or steam mixed with various gases) that rise with vast force in a continuous stream from within the molten matter exposed in the vent, consist for the most part of tattered and jagged fragments—scoriæ in fact, torn from the liquid surface, and cooling as they ascend in the air—some of

them shot up as still liquid drops, and therefore taking the form of "bombs" as they descend; but that these fragments are at first of some considerable size, and only become reduced to the comminution even of the ordinary "puzzolana," in which the grains vary from the size of a nut to that of sea-sand, and ultimately of "impalpable powder or dust," through the effect of their trituration *inter se* in the air during the process of repeated falls into, and rejection from, the crater. In proof of this I would adduce the fact, that not only were the fragmentary ejections from the Volcano in the earlier period of the eruption I have named visibly composed for the most part of coarse materials, but that day by day as the explosive bursts from the crater continued, the matter they projected and which fell from the air on the surrounding country, became finer and more pulverulent, until at length towards the close of the eruption after 20 days duration, it consisted solely of a powder so impalpable, that its distinct particles were undiscoverable by aid of the strongest lens I possessed, and which in virtue of this tenuity penetrated the closest apartments in Naples, wherever air could permeate, and lay thick upon the tables and furniture, even where all apertures were carefully closed.

2. Again, in p. 323, when describing the effects of a submarine eruption, Mr. Forbes says "the molten lava coming in contact with the water, is *at once* broken up into fragments, coarser or finer in proportion to the greater or less cooling power of the water in immediate contact with them, and often in great part *instantly* converted into fine mud . . . beds of which, spread out by the action of the sea, often enclose shells &c." Now what authority is there for this assertion that the contact of water with molten lava at the bottom of the sea instantly converts it into mud? It is very difficult, not to say impossible, to do more than guess at the effect produced on a body of lava expelled from a volcanic vent beneath water. But I am strongly inclined to believe that the reduction into coarse ash or fine mud of its superficial portions—for certainly the great bulk of submarine lavas have flowed upon the sea-bottom much in the same way as on dry land, spreading over the lower levels according to the ordinary laws of gravity effecting liquids—has been the result of continued trituration under the influence of the disturbed water, and not of any "instantaneous" division into powder by the sudden contact of sea-water. If we are to speculate on the probable effects of a submarine eruption (and we have naturally not many facts to guide us in this matter), it would seem most likely that any outbursts of steam which may take place from an exposed surface of lava, in such a position, would, if the depth of water above it were considerable—say 100 feet or more—be condensed long before they could reach the upper air. But these bursts may very probably drive upwards scoriæ and ash, that is tattered fragments of lava torn from its surface, just as when the eruption is sub-aërial. Such a jet of fragmentary lava would scarcely rise above the sea-level until the apex of the submarine volcano had been raised by the accumulation of ejected matter to within so short a distance of the surface as to permit the bursts of steam, *uncondensed*, together with the fragmentary matters they drive

up, to reach the open air. In either case the disturbance of the sea-water—whether at great depths through the repeated outburst and immediate condensation of huge bubbles of steam, or by the additional action of the waves when the mouth of the volcano had risen high enough to be affected by them—would amply account for the trituration of the fragmentary lava into the materials of ash or mud, as well as its spreading over large contiguous areas.

Thus, whether in the case of sub-aërial or subaqueous volcanic eruptions, I see no reason for attributing the fine division of the mineral matter which composes the fragmentary lava-rocks, commonly called volcanic ash, tuff, peperino, or puzzolana, to any sudden or instantaneous process, but to simple mechanical trituration, or the rubbing against each other of a crowd of coarse particles, forcibly set in motion, whether in the air or water.

Since, as I before observed, such fragmentary matter constitutes at least one moiety of all volcanic formations, of whatever age, the question of its mode of production is not unimportant.

3. With respect to the controversy as to the causes which have shaped out the terrestrial surfaces of the globe, I need only refer to the short paper which appeared in your number for June, 1866 (Geol. Mag., Vol. III., p. 241), to prove my entire accordance with the argument of Mr. Forbes (p. 327), that "the most prominent part in the determination of the external features of the earth" must be assigned "to its internal agencies," to which alone is owing the occasional elevation of great masses of land up to and often far above the sea-level, and their consequent exposure to the sculpturing and denuding influences as well of ocean waves and currents, as of the meteoric sub-aërial forces—rain, rivers, frost, glaciers, etc.[1]

4. The only other remark I wish to make on Mr. Forbes's lecture has reference to the mode in which he, as others have done before him, employs the word "Cataclysm," or "Cataclysmic," as involving an idea opposed to, or inconsistent with, that of "Uniformity" (p. 327, line 21).

I understand by a "Cataclysm" exactly what in my work on Volcanos I have preferred to call a "Paroxysm," i.e., a more than ordinary violent event in the physical history of the globe, as for example, an extraordinary earthquake, volcanic eruption, or flood, such as occurs perhaps but once in a century or even in a thousand years, but which is still perfectly consistent with the general uniformity of the terrestrial and cosmical agencies. The theory which is really inconsistent with that of Uniformity is what Professor Huxley calls Evolutionism, and which I prefer to call Progression or Progressive Development. Even Mr. Huxley has, it seems to me, abused the similar word "Catastrophical" by taking it to indicate a "tertium quid," a theory as much opposed to Evolutionism as to Uniformitarianism.[1] Whereas I conceive the idea of occasional Catastrophes or Paroxysms to be quite compatible with either theory.—Your obedient servant,

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[1] I observe that Colonel Greenwood, in your last number (p. 395), ridicules the phrase "meteoric," as applied to the sub-aërial denuding agencies, instead of "*rain and rivers*." But can he not see that his favourite formula leaves out the influences of alternate frost and thaw, of snow and ice, of electricity, chemical decomposition, etc., all more or less effective in wearing away the exposed surfaces of land? The Colonel seems, too, to claim for himself the origination of what he calls "the rain and river theory of erosion." Now, without denying the "originality" of much in Colonel Greenwood's volume, yet its first edition was printed only in 1857, and geologists are well aware that through half a century before that date the doctrine of the enormous influence of atmospheric agencies (rain and rivers inclusive) in moulding the surface of the earth had been earnestly advanced by Hutton, Playfair, Lyell, myself, and others. (See Quarterly Review for June, 1827, p. 477.)

Fairlawn, Cobham, Surrey. G. Poulett Scrope.

DISCOVERY OF FLINT-IMPLEMENTS NEAR FOLKESTONE, KENT.

Sir,—It may both interest some of your readers as well as stir up those dwelling in the neighbourhood to know that during the course of the last month, I found at Folkestone several Flint-implements. Along the sides of the footpath on the top of the cliff between Folkestone and Sandown, there is a low embankment, made probably of material collected off the adjoining fields; in this embankment the implements occur. They are mostly of the rude flake or "scraper" pattern. The first discovered, which was also the finest, was lying partly exposed on the top of the bank, and subsequently my brother and myself found several more not far from the same spot. I enclose sketches of the principal ones, and I have little doubt that further search in the same bank would bring many others, and possibly finer ones, to light.—I am, etc.,

St. Thomas's Rectory, Brampton,
Chesterfield, *Aug.* 16, 1870.
J. M. Mello, M.A., F.G.S.

[Note.—The locality referred to by the Rev. J. M. Mello is one of great interest and has been, we believe, already noticed by Mr. John Evans, F.R.S., Sec. Geol. Soc., Mr. W. Whitaker, F.G.S., and other gentlemen; by whom stone-implements have also been obtained thereabouts. A flint-flake, corresponding with the largest found by Mr. Mello, is figured on Plate xxvii. a. of the "*Reliquiæ Aquitanicæ*," by Messrs. Lartet and Christy. Figs. 4 and 5 of Mr. Mello's sketch resemble a "Flint piercer" from La Madelaine (Op. cit. woodcut fig. 52, p. 134, Part X) and an "Awl or Graver" (fig 23, p. 130. op. cit.). Both in Kent and Sussex, a large manufactory of flint-implements was undoubtedly carried on in prehistoric times.—Edit. Geol. Mag.

HALL'S MINERALOGISTS' DIRECTORY.

Sir,—In your notice of Hall's Mineralogists' Directory in the August Number of the Geological Magazine, p. 382, you express a hope that information as to omissions and errors will be liberally responded to by local collectors so that the new edition promised by the author may be more complete and accurate than the present one. Having used Mr. Hall's book for some time I have great pleasure in testifying to its general accuracy, at the same time I venture to offer a few notes on one district (Cornwall) with which I am well acquainted, which, perhaps, may be useful to some of your readers and also to Mr. Hall.

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[1] Anniversary Address to Geol. Soc., 1869.

At Huel Bassett the occurrence of 'Cassiterite' is omitted; at Pengelly of 'Millerite.'

At Stenna Gwynn 'Wavellite' is named in mistake for 'Tavistockite' (vide new edition of Dana).

The occurrence of 'Senarmontite' is not mentioned at Endellion. 'Uranochre' has never been found at the Royal Restormel iron mines, but only the 'Bismuthochre,' while 'Restormelite' is omitted.

Several important mines have been overlooked entirely, e.g., 'Silver Vein,' near Lostwithiel, in which is found Argentiferous Tetrahedrite; the 'St. Austell Consols,' producing Chalcopyrite, Kupfernickel, Cobalt, and Pitchblende; and 'Lanescot' or 'Fowey Consols,' in which occur Chalcopyrite, Chalcotrichite, Magnetite, Chalybite, Cassiterite (Wood-tin), Kupfernickel, Cobalt, Bismuthine, Millerite, Melaconite.

I would ask Mr. Hall why he uses the name 'Towanite' throughout his book instead of 'Chalcopyrite,' or Copper Pyrites, as the names are not synonymous, the former having been given by Greg and Lettsom to the modification found at Huel Towan; and also why he calls 'Limonite,' 'Limnite.' Limonite is derived from the Greek *λειμών*, a meadow, and is almost exclusively applied to the Brown Iron Ores; while 'Limnite,' from *λίμνη*, a marsh, is applied to the Yellow and Stalachtitic bog iron ores. To these varieties are given distinct formulæ in Dana's last edition, and, therefore, they may be regarded as species for the present.

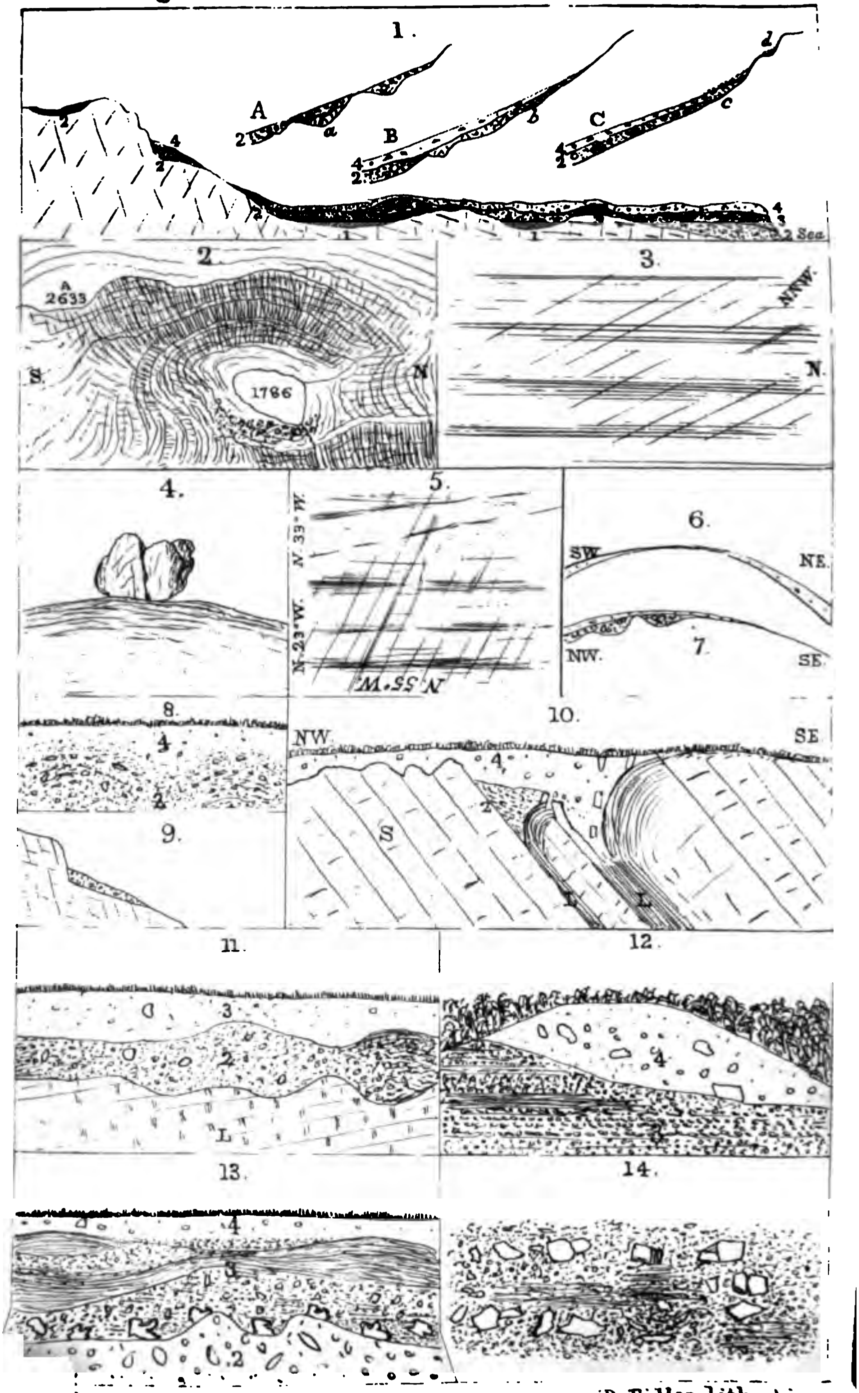
Apologizing for intruding on your valuable space I am, etc.,

BRACKLEY, *August* 22, 1870. B. J. R.

MISCELLANEOUS.

NEW BRITISH LOCALITY FOR AVANTURINE-QUARTZ.—This scarce variety of quartz has recently been observed by Mr. G. W. Traill in Orkney, on the S. and S.W. shores of Inganess Bay. It occurs in the form of small rolled pebbles, seldom exceeding an inch in diameter, but well marked, and occasionally fit for ornamental purposes. The colour is usually reddish-brown, but sometimes yellow. The scales of mica are very numerous, of a golden colour, small, uniform in size, and generally disposed in parallel planes as if they had settled in a liquid; but in a few of the specimens this regular arrangement does not appear. The reddish-brown variety is very compact, takes a high polish, and has a specific gravity of 2·62; the yellow is of a fine granular structure, and has a specific gravity of 2·60. This appears to be almost the only well-ascertained British locality for avanturine-quartz; and, as the rocks in the neighbourhood are entirely sandstone, the situation is somewhat peculiar.

THE CONGRESS OF ALPINE GEOLOGISTS which was to have been held at Geneva, on 31st August and the 1st and 2nd September, is indefinitely postponed, owing to the present unsettled state of Europe.



elt.

D. Fidler, lith. et imp.
Cockermouth.

eol. Mag. 1870. Vol. VII. Pl. XXV.

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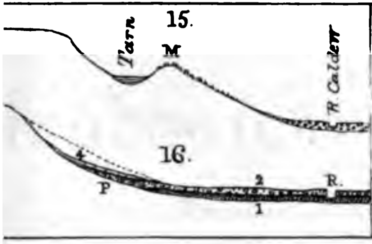

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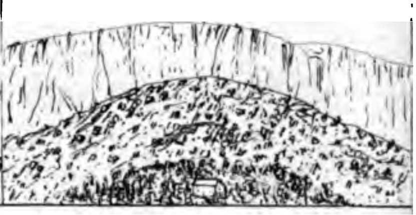

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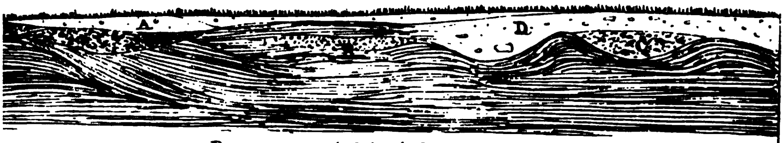

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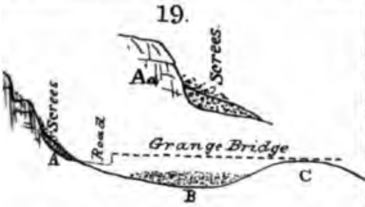

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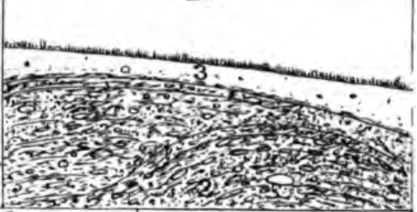

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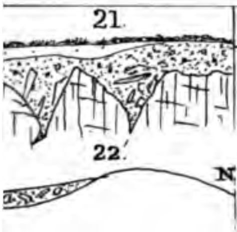

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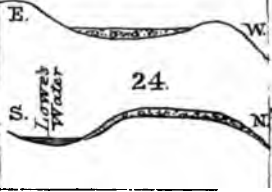

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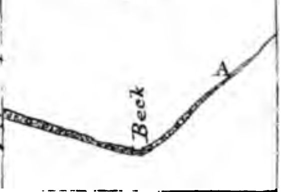

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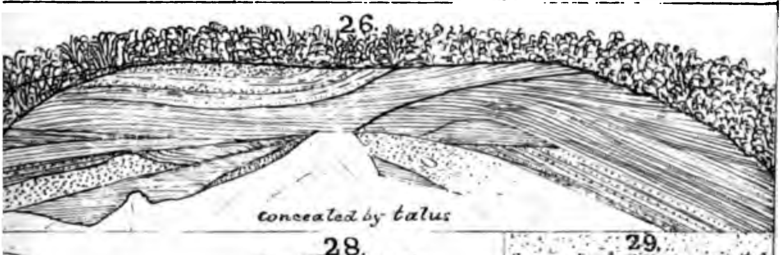

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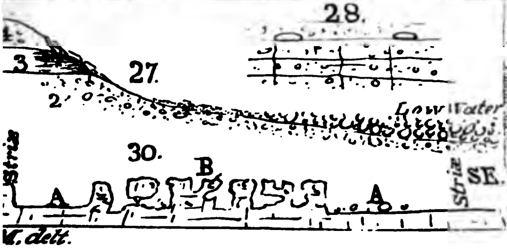

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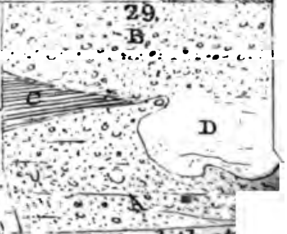

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THE
GEOLOGICAL MAGAZINE.

No. LXXVI.—OCTOBER, 1870.

ORIGINAL ARTICLES.

I.—On the Origin of the Drifts, so-called Moraines, and Glaciated Rock-Surfaces of the Lake District.[1]

By D. Mackintosh, F.G.S.

(PLATES XXIV. and XXV.)

THE Lake District differs from other parts of England in the comparative absence of table-lands or broad upland plateaux. The original mountain-masses have in most parts been eaten into by denudation to such a depth as to leave only a series of narrow ridges or edges which act as buttresses to small peaks. When the pedestrian has climbed up from the inner end of one profound excavation, he finds himself on the brink of another. The larger valleys are deepest at their inner ends, and shallow out and narrow off towards their entrances. Their floors fall so slightly outwards that were the outlet stream-channels to be filled up, the valleys would be converted into troughs. In most instances their mouths are confronted by higher ground, and this is sometimes so strikingly the case that in approaching a valley from the surrounding belt of Carboniferous strata, you find yourself going *down* instead of up among the mountains. The highest ground is not in the centre, but irregularly surrounds a comparatively depressed area about ten miles in average diameter. Such a configuration of country could not have been the best adapted for accommodating a quantity of snow at a high level sufficient to send very large "tongues of ice" along the radiating valleys. During the glacial period the whole district was probably enveloped in an ice-sheet, which may have glaciated rock-surfaces, and, by its grinding action, worked up a great part of the matter now composing the Boulder-clay; but the surface-configuration of the district renders it difficult to conceive how, during the gradual increase or diminution of the ice-sheet, very extensive glaciers, separated by ridges not buried under ice, could have been supported in at least many of the valleys. In favourable positions, however, valley-glaciers may for a time have existed, and may have smoothed and striated rock-surfaces. They may likewise, especially in the more abrupt-sided valleys, have intercepted and collected falling screes, which of course would form moraines. A part of the débris may have found its way through cracks to the beds of the glaciers, and terminal moraines, resulting from the shedding of supra-glacial detritus, may have become mixed with protruded sub-glacial mud and stones. But the constantly-encroaching sea, during the sinking of the land, must have re-distributed the moraine matter (as Professor Ramsay has shown it must have done in North Wales) to such an extent that it would now be unreasonable to look for many instances of unmodified glacial moraines in the lower valleys of the Lake District. The existence of false-bedded sand and gravel up to at least 1,000 feet above the present sea-level, (*see sequel*) shows that the country was certainly submerged to that extent, and the mode of occurrence of Boulder-clay at higher levels would seem to indicate a deeper submergence, so that very few unmodified moraines of the pre-marine set of glaciers are probably now to be found.

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[1] In the article on Shapfell Boulders (Aug., 1870, Vol. VII.), p. 350, line 9 from foot of page, for *Stainmore*, read Stainmoor; same page, line 13 from foot, the *l* in Kendal was omitted.

In the Lake District the true glacial moraines, consisting mainly of ridges or banks of loose angular stones, are chiefly, though not exclusively, to be seen in upland valleys and cwms, where they were probably shed by small glaciers after the emergence of the land. At low-levels the moraine-matter, along with matter detached by the direct action of the sea, has been so rearranged that the external form of the hillocks, knolls, and ridges, supposed by many observers, at first sight, to be real glacial moraines, is merely a continuation of the contour of the undulations which diversify the surface of the drift-deposits in the valleys, on the plains, and along the sea-coast. Where good sections are obtained, many of the reputed moraines are found to consist of pinel, often distinctly surmounted by loam, both of which are an inland and upland extension of the general Boulder-clay of the N.W. of England.[1] From Troutbeck, Windermere, Kentmere, Ullswater, Borrowdale, Crummock, and other valleys, the alternating flat expanses, and knolls and basins of drift, run out to great distances along the neighbouring plains, where they ramify in various directions.[2] There is no difference in form between the plateaux and undulations at the lower end of Troutbeck valley and those which cross the watershed between Windermere and Kendal, and run along between Kendal and Lancaster, while, in internal structure, the difference (where any difference exists) is only what may have resulted from a deep or shallow sea, flat or sloping ground, and a greater or less share of ice-action in connection with that of water.

The theory of a general ice-covering, with an *ice-foot* changing its level upwards as the land went down beneath the sea (as ably worked out by Mr. S. V. Wood, jun., F.G.S.), is a very convenient, if not absolutely necessary, part of a consistent explanation of the sequence of events during the glacial period or periods. But it becomes a question how far this ice-foot may have maintained its hold of the mountain slopes until forced to relinquish it by the encroaching sea, or how far, through an amelioration of climate resulting from astronomical causes, the ice-foot may have retreated upwards in advance of the sea.[1] It would appear evident that at certain levels at least the ice-foot must have kept at a sufficiently respectful distance from the sea to leave room for coast ice to act unfettered. (See Article on Shapfell Boulders.) Many, if not most of the boulders which form a part of the Boulder-clay formation,[2] must have radiated from the lower (if not from some of the higher) hills and slopes in various (including opposite) directions, in a manner inconsistent with the pressure of a general ice-foot on the sea-coast. Many of the stones have been uniformly striated on one side—an effect which may have been produced under both land and sea-ice, but most of the stones have been striated in various directions in a manner most likely to have taken place under sea-ice. The stones are often the most polished and striated at a distance from the mountains. Most of the stones away from elevated hill slopes, where they are generally, but not always, angular or subangular, have evidently been much rolled, and the cause or mode of their attrition is not easily explained. The process may partly have occurred on sea-shores now indicated by upland plateaux or slopes of drift. But the comparative absence of well-rounded stones at high levels necessitates our supposing that after the stones were dropped into the sea by floating ice, they must have been rounded by powerful currents or ground-ice, for their distribution in the clay must chiefly have taken place beneath the reach of wave-action. That a great part of the Boulder-clay, including its stony contents, was distributed under water, is evident from the fact that where in inland districts, or on the sea-coast, this clay has been newly-washed by flooded streams or by waves, or where perfectly fresh sections have been exposed by the tumbling down of masses, it generally presents the appearance of stratification, and even false-bedding, as much as the nature of the deposit could have allowed it to receive or retain.[3]

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[1] Many, if not most of these mounds exist, because the drift of which they consist was directly, or indirectly, arrested by a projecting boss of rock.

[2] The regularly flat or curvilinear surface of drift-deposits is owing partly to deposition and partly to denudation. It could only have been left by the sea, as the effect of rain is to rut down the sides of the knolls and break up the plateaux, while rivers either make well-defined channels in the plateaux, or, by encroaching on the knolls, convert their slopes into cliffs.

Over an area extending from Long Sleddale on the E. to Coniston Old Man on the W., and reaching at least as far north as Ambleside, I have found the primary glaciation of rock-surfaces almost invariably pointing to between N. and N.N.W. At first[1] I was led to regard this as the effect of a great flow of land-ice not generated in the Lake District itself, but embracing the country in its progress southwards from an unknown source. But after finding that the northern half of the Lake District was glaciated chiefly from the S, S.W., or S.E., without any great persistence in a particular direction, and believing that the interior of the country could never have sent off a sheet of land-ice in a southerly direction capable of moving so uniformly and independently of hill and valley, I was driven back to the theory of floating ice as the cause of the uniform primary glaciation of the area between Long Sleddale and the Old Man, notwithstanding the difficulties with which the theory is beset. In this area most of the *roches moutonnées* could not have been smoothed by valley glaciers; and in the northern part of the Lake District, after observing the direction of the glaciation, and looking back, one is often puzzled to see where a glacier could have come from, even after making allowance for deflections and windings. It is very common to find the sides of valleys glaciated obliquely uphill, and bosses of rock with their smoothly-rounded or upstream sides pointing to hills or cliffs. The tops of steeply-sided hills of considerable height are likewise often "moutonnéed." In all such cases it seems more reasonable to assume the agency of floating ice than to invest the interior of the country with a power of originating and propelling ice-streams incompatible with its physical geography.

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[1] The character and mode of occurrence of the blue clay of the N.W. of England, but especially of the West Riding of Yorkshire, (see Paper on the West Riding Drifts in forthcoming Proceedings of the West Riding Geol. Soc., noticed in GEOL. MAG. of last June,) suggests another question, namely, whether the submergence commenced before the arrival of a comparatively mild climate, followed by a second sub-glacial period. This, of course, supposes that the *astronomical* may have been sufficient to neutralize the *geological* causes of climatal revolutions.

[2] These boulders are not merely surface-blocks, but are often deeply imbedded, and most numerous towards the base of the deposit.

[3] Mr. Hull and Professor Ramsay both arrived at the conclusion that the two Boulder-clays of Lancashire were stratified. Mem. Lit. Phil. Soc., Manchester, for 1863–64.

The following notes, with the sections, (see Plates XXIV. and XXV., and Explanation) will, it is believed, furnish facts and considerations corroborative of the foregoing general observations:—

From Coniston to Tilberthwaite and the Old Man.—At the mouth of Tilberthwaite valley there is a plateau of drift which has been breached through by the stream, or by a valley-glacier which has left no traces of moraines excepting perhaps scattered loose blocks. The sea, however, may have arranged this drift out of matter furnished by a general covering of land-ice. Above this drift, on the S.W. side of the valley, the rocks have been extensively glaciated uphill, apparently from the north, or in a direction obliquely crossing the mouth of the valley. Farther on, many sections of hard pinel have been exposed. It often rests on glaciated rock-surfaces—is full of stones, which sometimes occur in clusters or pockets—and only occasionally contains large boulders.

On walking up the Church Beck valley from Coniston, one first encounters mounds of pinel and stratified sand and gravel, which are probably moraine matter re-arranged by the sea. Before reaching the Coniston Copper Works, on the right hand or N.E. slope of the valley, a very extensive display of glaciated rock-surfaces may be seen. The primary grooves run from N. to S., or obliquely down the slope, and land-ice from the N. could only have produced them after crossing the high ridge which rises between the Church Beck

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[1] See Scenery of England and Wales.

Valley and Tilberthwaite. The secondary striæ run from N.N.W. to S.S.E., or along the side of the valley. (Plate XXIV., 3.) Farther on, behind the Coniston Copper Works, the rocks have been smoothed and striated downhill from a little W. of N., and on the nearly opposite slope, S. of Pudding Cove, several *roches moutonnées* have been smoothed uphill in about the same direction. The configuration of the ground renders it obvious that the N. and S., or nearly N. and S., glaciation of the valley under notice could not have resulted from any ice-flow generated within the limits of the Lake District.

Along the N.E. slope of the valley, below the Coniston Copper Works, pinel lies on glaciated rock-surfaces, and is overlain by a deposit of sand and gravel, the latter sometimes resting on glaciated rocks. Stratified sand with gravel here rises to a height of 200 feet above the bottom of the valley, and extends along the side of the valley, as far at least as the Copper Works, with a smooth and continuous surface, excepting where it has been rutted by rain-torrents and permanent streams. It presents fine specimens of oblique lamination, and differs in no respect from the middle sand and gravel of the Lancashire plains. Towards the base of the slope it attains the thickness of at least forty or fifty feet. Between the slate quarry (a short distance from the Copper Works) and the mouth of Reddale, the rounded gravel graduates into sub-angular and angular detritus, which, like a sloping sea-beach, runs up to the bases of the cliffs (about 1,200 feet above the sea), where it differs from recent screes in its being covered with grass. Rounded gravel on this slope may be traced up to 1,000 feet above the sea. The whole of the drift covering of this slope, with its base of pinel, differs from any form of a glacial moraine, and up to a great height contains striated boulders, sometimes close to the surface. At the bottom of the plateau, near the Copper Works, there is a nearly level expanse of finely-laminated brown loam. It cannot be attributed to the action of the stream which here flows along the plateau, for it has not yet in many places succeeded in cutting a channel through the pinel which covers glaciated rock-surfaces in the lowest part of the valley. In other places, as at the outlet of Reddale valley, the stream has only got a few feet beneath the level of the glaciated rocks. The laminated loam in some places rises to heights at which the stream could not have flowed since the glaciation occurred, unless in a bed consisting of drift. The laminated loam, however, is not reassorted drift, but is so associated with the lowest drift or pinel as to show that both must have been formed at the same period. It runs over the pinel, down into the pinel, is interstratified with the pinel, and runs under the pinel. It looks like the equivalent of the finely-laminated loam associated with lower Boulder-clay I saw on the beach at Blackpool. In both places the laminæ are curved and waved to a remarkable extent, and here a long section reveals oblique lamination, subsequent denudation, redeposition, and other indications of current-action. Towards the Coniston Copper Works, the upper boulder-earth above the loam reaches a considerable thickness, and contains large striated stones. Farther N.W. the laminated loam reappears. It may be traced at intervals, interwoven with pinel, at higher levels, between the Coniston and Paddy End Copper Works.[1]

The distinction between drift accumulated under water and a subaërial glacial moraine, may be seen after climbing up to Low Water, which lies in a cwm about 900 feet below the summit of the Old Man. Behind the rocky barrier of the tarn, the water is dammed back by a very conspicuous ridge of loose angular blocks, many of them from 6 to 24 feet in length. (Plate XXIV., Fig. 2).

In Pudding Cove, below Low Water cwm, there are many loose blocks which may have been partly left by a glacier. But there is one split block resting on a rounded mass of rock, which would appear to have fallen from floating ice (Plate XXIV., Fig. 4).

Around Windermere.—The larger knolls between Windermere and the lake, and extending in a N.W. direction, consist partly of pinel often covered with foxy-coloured loam, and partly of rock sometimes moutonnéed. The smaller knolls are often clothed or half-clothed *roches moutonnées*. Near the house of Mr. Atkinson, wine-merchant, there is a rounded boss of rock covered with drift, as represented in Figs. 6 and 7, Pl. XXIV. It is difficult to conceive how a glacier, capable of grinding a rock uphill, could have left it covered with pinel and loam on the up-stream or N.W. side. In front of The Ferns, Windermere, there is an instance of what may often be observed, namely, a sharp line of demarcation between the hard pinel and foxy-coloured loam. In the churchyard, the rock is smoothly grooved and fluted N. 25° W., and sharply indented N. 10° W. Above Ellerlay rudely laminated pinel (Pl. XXIV., Fig. 8) may be seen under a rocky escarpment like an old sea-cliff. Orrest Head, 600 feet above the sea, is to a great extent moutonnéed, but no valley glacier, and I believe no district flow of land-ice, could have marched up hill to so great a height. This must have been still less likely in the case of the higher ridge called School Knott, S.E. of Windermere, which has been moutonnéed and grooved from N. 33° W.; and, like many other moutonnéed heights, afterwards scarped by an agency acting irrespectively of the direction of the glaciation, and capable of detaching and removing blocks where they could not have fallen. School Knott is a part of a ridge running parallel to other ridges E.N.E. and W.S.W. These ridges and the hollows between them have been glaciated crosswise at nearly right angles. The ridges, therefore, have not been formed by land-ice moving in the direction of their length, and this remark applies to the parallel ridges N.E. of Shap, and elsewhere. Near the Crossings, S.E. of Windermere, after clearing a rock-surface of soil, I found a magnificent display of general or primary smoothing and grooving, crossed by secondary and tertiary striæ. (Pl. XXIV., Fig. 5.)

From Windermere to Kirstone Pass, through Troutbeck Valley.—I took the near road from Windermere, crossed Troutbeck valley, and on ascending the western slope was not surprised to find real pinel clinging to the hill-sides. It sometimes rests under a cliff, as represented in Pl. XXIV., Fig. 9. It was quite distinct in its nature and mode of occurrence from fallen débris or screes, though a part of it may have been reformed out of scree-matter. It contained very few large, and many very small stones considerably rounded. On the eastern slope of the broad and flat watershed between Troutbeck valley and Kirston Pass, there are enormous masses of pinel, surmounted by red loam. Here it contains large boulders which, however, appear more numerously scattered over the surface. It often presents an arched form of lamination. Near to the Pass, and at least 1300 feet above the sea, I saw a fine section of very hard pinel consisting of gritty clay and very small rounded stones with arched lamination. No signs of glacial moraines could be detected (during a former visit) in the valley leading from the Pass to Ambleside, though here and there the rocks are covered with drift, which may have been partly derived from moraine-matter. On returning to Windermere through the lower part of Troutbeck valley, I was struck with the enormous accumulations of pinel (surmounted by loam) which in many places, as revealed by river-sections, must be 150 feet thick. It either rises into knolls, or more frequently stretches across the valley with a continuously flat surface, excepting where it has been cut through by the river and tributary streams. It rises up the sides of the valley to a considerable height, crosses the high watersheds which communicate with other valleys, and curves continuously round the hill slopes to the right and left of the mouth of Troutbeck valley, so as to graduate into the drift of the N.E. side of the Vale of Windermere, and all this in a manner at variance with the idea of its being unmodified glacial moraine-matter.

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[1] Scenery of England and Wales.

From Windermere to Ambleside and Loughrigg Tarn.—On the roadside, not very far from Low Wood Hotel, I noticed, in a small quarry, the section represented in Pl. XXIV., Fig. 10. I think it is easiest to conceive of the curving of the laminated slates having been caused by floating ice suddenly grounding and dropping down fine pinel into the vacancy (2), the loamy clay (4) having been afterwards washed in. The well-known rock in Ambleside churchyard has been glaciated from N. 15° W., the jagged side of the boss looking nearly S. There are no superficial accumulations in this neighbourhood, excepting screes and river shingle, which may be regarded as distinct from drift. Near Pull Bay House, on the Hawkshead road, a rock-surface has been glaciated from N. 27° W. About half a mile beyond Brathay Church, on the N. side of the valley, there are striæ from the N.W. crossed by others a little north of W., the former pointing over Loughrigg Fell to Grasmere, the latter to Langdale. Farther on, near Mill Brow, very hard laminated pinel makes its appearance. Near Loughrigg tarn, barely distinguishable striæ may be seen running from N.W., and faintly crossed by others pointing N.N.W. The small stream-channel from the tarn has been choked up with drift and boulders. Opposite the tarn, on the roadside, there is a considerable mass of yellowish-brown pinel, with a few stones striated lengthwise.

From Windermere to Kentmere.—Kentmere valley is a trough, with a narrow outlet gorge which could scarcely be seen from the moon with the largest telescope yet constructed. The sloping cliffs rise from its inner end to a height of nearly 2,000 feet, and though likely to have showered down quantities of screes on a valley-glacier, no traces of moraines, except perched and scattered blocks, are to be found. In the lower part of the valley, the small and steep-sided mounds are pinel and loam, in some cases tailed on to projecting rocks. On a broad pass between Kentmere and Long Sleddale, I found an instance of rock-grooving due N. and S., or nearly in a line with the dividing ridge, at a height of at least 1,000 feet above the sea. On this pass there is much pinel. Kentmere valley, compared with Troutbeck, contains wonderfully little pinel or drift of any kind.

From Windermere to Kendal.—Between Windermere and Staveley there are knolls of pinel and loam on the summit-level of a broad pass, from which the ground slopes to the W. and E., and rises to the N. and S., in other words in a position where it is impossible the knolls could have been left by a glacier. Similar knolls may be seen between Staveley and Kendal, between Kendal and Carnforth, etc. To the W. of Ings there is the finest series of *roches moutonnées* perhaps to be found in the Lake District. They have been smoothed nearly all round, and grooved and striated from between N. 20° W. and N. 30° W. They are partly covered with pinel and loam. On looking northwards the configuration of the ground does not certainly suggest the idea of land-ice having glaciated these large bosses of rock. Among the knolls of drift to the N. E. of Kendal, Meol Bank is particularly worthy of notice. Under the red gravel and loam on which part of Kendal is built, I saw typical yellow pinel exposed in a deep drain cutting.

Around Penrith.—On the road to Clifton large boulders are cross-striated and grooved in all relative directions, including right-angles —a few limestone and some Shap and greyish granite boulders, but at least nine-tenths of the stones gathered off the fields and broken on the roadside (and this remark applies to the country W. and N.W. of Penrith) are a bluish porphyry, both fine and coarse, which could only have come from the Lake mountains to the S.W., or the Carrock and Caldbeck Fells to the N.W. In either case they must have been *floated*, otherwise they would have become largely intermixed with the intervening limestone and other rocks. Opposite Brougham Hall, the river Lowther has exposed a section of stratified fine gravel with a little sand, overlain by a great thickness of reddish boulder-clay, with comparatively few stones (Pl. XXIV., Fig. 12). E. of the Penrith railway station, a section of variegated but chiefly reddish-brown boulder-clay, very hard, has been exposed by digging a foundation for a house. Near Stainton, hummocks of similar clay underlie an extensive deposit of sand and gravel, the stones and boulders in which are chiefly different from those in the boulder-clay near Penrith. In its lower part there are several large, rough, and angular limestone boulders, which look as if they had been violently uprooted from the limestone rock on which the drift reposes, and immediately covered up. The sand and gravel is extensively false-bedded, and above it there is a thin covering, like a washing of reddish loamy clay of the same kind as that concealing the limestone of the neighbourhood (Pl. XXIV., Fig. 13). On the right-hand side of the road from Penrith to Greystoke, a boulder, 6½ × 6 × 4 feet, stands on end in a field. It is a breccia with included fragments up to 1 foot in diameter, to which it would be difficult to assign a parentage, as it may have come from one of many parts of the Lake district. This remark applies still more to boulders of porphyry. In a sandstone quarry near Bunker's Hill, I found the newly-bared rock distinctly striated N. 10° E., a direction about the most unlikely of any which could be assigned to the course of a stream of land-ice. On the W. side of Penrith Beacon (which is covered with sand containing erratics) the striæ (not very distinct), on Permian sandstone, run in the direction of N. 30° W.

From Penrith to Ullswater.—Around the foot of Ullswater the drift, so far as can be seen, consists of pinel running into, or interstratified with, gravel and sand, and covered with a loam, more or less stony, which runs up and thins out towards the summits of the hills. On the west side of the lake, and south of two conical wooded heights, a flat, beach-like plateau of drift runs up into a lateral recess. On the east side of the lower reach of the lake, the drift runs along continuously with an almost perfectly flat surface, like a tidal zone. Nowhere around the foot of the lake can the slightest trace of a moraine be found, while N.E. of the outlet the ground is more or less covered with boulder-clay, or with smoothly-swelling expanses of red pebbly loam passing into sand. At the foot of Ullswater the Old Red Sandstone might be called pinel, were the matrix of the stones and boulders clay instead of sand (Pl. XXIV., Fig. 14). It is made up of stones of all sizes, up to 18 inches or more in diameter, resting at all angles, and closely packed in a matrix consisting of ground-up grit, sand, and very small half-rounded pebbles, with seams of the latter rudely laminated.

From Penrith to Keswick.—All the way from Penrith to Keswick, the railway has been cut chiefly in a reddish or yellowish-brown boulder-clay (No. 2 of the sections), which rises to a height of at least 1300 feet on Matterdale Common. W. of Troutbeck station, if not before, a greyish-blue clay makes its appearance under the brown. It varies from a clayey gravel with many pebbles to a clay with a few good-sized stones and boulders. At least 900 feet above the sea I found the blue clay packed full of small stones as much rounded as on any sea-coast where a second attrition has not come into operation; and Mr. Ward, F.G.S., of the Geological Survey, gives me leave to state that he has found false-bedded sand and gravel S. of Troutbeck station at an altitude of 1,000 feet above the sea—an altitude corresponding with the upper limit I have assigned to stratified sand and gravel on the slopes near Coniston. Between Troutbeck and Keswick, the blue is seen to be distinctly separated from the brown clay where fresh sections are exposed. The stones in the blue clay are more numerous and more rounded and smoothed than in the brown. In both clays there are boulders which generally occur in isolated groups. Among the erratic stones porphyry is common, and here and there large as well as small blocks of syenite from the hill called the Knotts, under Cliff Head, may be found imbedded or lying on the surface. This hill, which is thickly strewn with loose blocks, is very rudely represented in Pl. XXV., Fig. 17. The syenitic boulders would appear to have been floated chiefly in a north-easterly direction. Between Threlkeld and Keswick the blue clay may be seen rising in hummocks under the brown. The lower part of the S. side of Saddleback is covered with drift, which, in one instance at least, runs up into a cwm (above Doddick). Near Doddick, a brook section reveals the drift as a pinel equivalent, I believe, to the brown clay lower down. The pinel is more or less covered with loam (Pl. XXV., Fig. 16).

From Keswick to Bowscale Tarn.—After leaving the valley of the Greta, I entered the Glenderaterra ravine, and walked along the N.W. slope of Saddleback to the brink of Bannerdale Crags, which overhang about the most perfect specimen of a cwm I have yet seen. Its floor is flat and broad, and the cliffs on the W. and S.W. side are probably 900 feet in height. Soon after, on coming suddenly to the brink of Bowscale cwm, a gentleman who accompanied me waved his hat, and exclaimed, "Hurrah, a glacial moraine!" and a moraine certainly seemed to dam back the tarn, which brilliantly reflected the sun's rays (notwithstanding guide-book assertions to the contrary) about 500 feet below. On scrambling down, we could see no section of the moraine-looking ridge. A great part of the nucleus probably consists of rock or of the outscoopings of the lake-basin, but the blocks on the surface and scattered down the subjacent slope are probably the equivalents of a post-marine corry moraine (Pl. XXV., Fig. 15). Lower down, the S. side of the Caldew valley is covered with drift, with erratic stones, including Skiddaw granite, which is continued as far as the mouth of the valley, where it graduates into the drift of the great Cumberland plain. Carrock Fell, on the N. side of the Caldew valley, is so thickly and completely covered with loose blocks of porphyry and syenite, that it must have helped largely, during the glacial submergence, to supply the drifts of the neighbourhood, if not of distant areas, with their stony contents. Boulders of Skiddaw granite have been carried down the Caldew valley, and likewise down the Glenderaterra ravine (at the mouth of which, on the side of Lonscale Fell, they may be seen at a considerable elevation) in a manner which cannot be satisfactorily explained by the agency of land-ice.

From Keswick to Helvellyn.—On entering Naddle Beck valley, one may see a boss of rock glaciated from the direction of the adjacent slope, instead of pointing towards any valley along which a glacier could easily have come. Between Shoulthwaite and Bridgend grey pinel, covered with foxy-coloured loam, may be seen under a cliff. Beyond, on the watershed, and away from any stream, an extra rounded mass of gravel abuts against a glaciated face of rock. Further on rocks have been glaciated uphill, and still nearer to Bridgend pinel covers up glaciated rock on a steep slope. It is difficult to conceive how a glacier could have found its way to this watershed from above or below, so as to glaciate the above rocks in the positions they occupy, and in the directions indicated. The rocks S. of St. John's Castle rock have been glaciated from the S.S.W., or obliquely uphill. These facts seem to favour the idea of floating ice having been the glaciating agent. On ascending Helvellyn from Stybeck by the steep miner's road, I was able to trace rounded and not merely blunted stones up to at least 1,000 feet above the level of the sea. The ravines on the W. side of Helvellyn have been filled up with drift in which the brooks are re-excavating channels. The foundation of the drift is pinel. On the borders of the flat and wide watershed between Stybarrow Dodd and the Raise, pinel occasionally shows its yellow face under a capping of peat, and on the summit-level, at a height of 2,500 feet above the sea, I could not convince myself that there were not rounded stones imbedded in a loamy clay, in places where they were exposed by the removal of peat. But assuming that these stones and clay represent the upland extension of the undoubted Boulder-clay, it is difficult to conceive how land-ice could have deposited them at so great an altitude in such a position.

From Keswick to Borrowdale.—The foundation of the drift immediately around Keswick and to the S., N., and W., is pinel. A good cliff section of it may be seen near Derwent Isle, where it apparently runs under Derwent water. Between the eminence called Castle Head and the base of Wallow Crag, on a watershed nearly 400 feet above the sea, and about 150 feet above the level of the lake, there is a deposit of sand, clay, fine gravel, and pinel, interwoven, and contorted in a manner that can only be explained by the combined action of ice and water. A section of it is exposed in a shallow pit about a quarter of a mile above the Keswick and Borrowdale road (Pl. XXV., Fig. 18). On the road from Barrow to Watenlath, pinel surmounted by loam, may be seen covering the hill slope, and presenting the characteristic style of lamination represented in Pl. XXV., Fig. 20. Further on, a flat rock-surface may be seen glaciated apparently from the north. In Barrow Wood the pinel presents the appearance of having been splashed into the cavities and crevices of the rocks (Plate XXV., Fig. 21). At a great height above Lowdore, the Watenlath road runs under a fine range of cliffs. At their base the rocks in some places have been glacially planed, the striæ running N. and S. Near Watenlath Beck the rocks have been moutonnéed from the S.E. On walking down towards the Keswick road, above Lowdore waterfall, large bosses of rock may be seen with their jagged sides pointing N.W. and their glaciated sides towards Brown Dodd, which rises abruptly behind them. Before arriving at Grange, one may see rocks glaciated in a direction away from high cliffs which rise abruptly behind, and with their jagged sides pointing to the open country. But such phenomena are far from being rare in the Lake District. Near Grange Bridge, at the base of the rocky escarpment, on the left of the road, thoroughly rounded gravel with seams of sand may be seen running along like a sea-beach. It graduates horizontally into pinel, and is here and there covered by recent screes from the cliffs above. The gravel contains boulders, and has not been washed like the river-gravel in the neighbourhood. There is no appearance, moreover, of the river having flowed at this level since the glacial period. That the river has been filling up rather than deepening its channel, is evident from the fact that a finely glaciated boss of rock runs under a mass of shingle in the river-bed at Grange Bridge (Pl. XXV., Fig. 19). Well-rounded gravel, graduating into pinel, may here and there be seen at the bases of cliffs, or filling up hollows, all the way from Grange to beyond the Bowder-stone. Opposite the Castle Crag, on the roadside, there is a great mass of very hard greyish-brown pinel with stones and boulders. The rocks in the narrow part of Borrowdale have been extensively glaciated and moutonnéed from the S., S.W., or S.E. Land-ice may here have played an important part, but the following facts would seem to suggest the action of the sea and floating ice. Under Castle Crag the rocks have not only been moutonnéed, *but minutely* rounded and hollowed as if by wave-action. Beyond the Bowder Stone, abrupt hollows have evidently been ground out irrespectively of the structure of the rock by the whirling round of stones. The *roches moutonnées* form part of a prominence, the outline of which is completed by a deposit of pinel or loam, which is often on the *up-stream* side, where land-ice would not be likely to have left it (Pl. XXV., Fig. 22). The tops as well as sides of hills (the Brund, for instance) are glaciated at a height above Borrowdale, too great to have been effected by a glacier, or ice-stream, proceeding from any conceivable part of the country. Beyond Rosthwaite, there is a large deposit of pinel and loam, with stones more or less rounded, which might easily be mistaken for a glacial moraine. From Stonethwaite (where my three visits to Borrowdale terminated), I could plainly see traces of post-marine glacial moraines in Greenup ravine, which might be expected, as it slopes longitudinally, and is backed by a considerable extent of elevated ground.

From Keswick to Buttermere.—In the neighbourhood of Portinscales, there are large knolls, which consist chiefly of pinel. Towards Bassenthwaite Lake the pinel seems to graduate into reddish brown Boulder-clay, which here and there overlies greyish-blue clay. On the flanks of Skiddaw, above Lyzzack Hall, up to a height of 900 feet,[1] boulders may be found which must have been floated from a distance of at least four or five miles; and from the road to Ullock, one may distinctly see a large boulder on the edge of a precipice which must have been floated from behind Barrow, on the east side of Keswick Lake. The N.W. slope of the vale of Newlands exhibits very few boulders, and scarcely a surface-block. There is here and there a little pinel, but the general covering of the slope is what may be called a chip-drift, which, though it may be overlain by recent screes in some places, is generally arranged in a manner suggestive of deposition under water. At the head of the valley, north-west of High Robinson, the slate rocks may be seen striated N. 30° E. Near Buttermere, the glaciation (apparently up-hill) is in the direction of the vale of Newlands. There are considerable deposits of boulder pinel, with its frequent loamy covering along the N.E. side of Buttermere, and in the neighbourhood of Gatesgarth. Between Gatesgarth and Honister Crag, the glaciation has been chiefly in the direction of the narrow valley.

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[1] Mr. Ward's Lecture on Ice (Trübner & Co.).

From Braithwaite up Coledale Valley.—The mouth of Coledale valley has been choked up with innumerable boulders of porphyry, breccia, etc., and they may be traced nearly to the head of the valley. They rise to a height of at least 300 feet above the beck. They must have come from the S.E. or S. of Keswick, to the mouth of the valley whence they were floated *up* the valley, or they may have passed over the high ridge called Barrow, which bounds the valley on the S.E., when the land was deeply submerged. Though many of these boulders are exposed in the course of the beck, they are a part of an extensive deposit of pinel and loam which, with a continuously flat surface, runs along from the lower end to the head of the valley. From the lower end the deposit spreads out over the adjacent plain. There is no trace of glacial action in this valley, so far as I had an opportunity of observing. The drift containing erratic stones up to a height of at least 600 feet above the sea, clings to the very steep N.W. side of the valley, and thins out upwards, as represented in Pl. XXV., Fig. 25.

Around Cockermouth.—In Embleton valley knolls of Boulder-clay and stratified gravel and sand may be seen, especially on or near the watershed. In the plain to the west, knolls and plateaux, partly or wholly consisting of stratified and false-bedded sand and gravel, may be found both on elevated ground and in valleys. The Derwent has cut a winding channel among these knolls and plateaux, and revealed some extensive sections. Near Camerton, sand and gravel resting on rock lie under a bed of loamy clay, with a few boulders, and sections of sand and gravel may be seen in many other places; but the principal deposit between the Lake Mountains and the sea is reddish-brown Boulder-clay, which is often underlain by greyish-blue clay running into unwashed gravel. An upper red loamy clay, with few boulders, makes its appearance here and there (as near Camerton), and attains a great thickness on some parts of the sea-coast, as at Maryport, where it rests chiefly on rock. It was probably deposited during a second submergence of the land. The boulders are principally found in the reddish-brown clay, which in some places attains a thickness of at least 100 feet. They are chiefly imbedded, and along with the smaller stones (which are often very much rounded) consist of grey porphyry both fine and coarse (either from the Caldbeck Fells to the N.E., or the interior of the Lake District to the S.E.), reddish, pinkish, and light-grey syenite (gradually disappearing to the N.W.), quartz from the Skiddaw slate formation, a very hard dark rock locally called whinstone, etc., with very little limestone even where the drift rests on limestone. On the summit of the Moota limestone ridge (north of Cockermouth), at a height of 800 feet above the sea, there are numerous fragments of porphyry, more or less tesselated with distinct crystals of felspar, which could only have been floated from the Caldbeck Fells (?) during a deep submergence of the land. The largest surface-boulder I have seen in the district under notice is near Bole or Bothel. It is apparently a kind of metamorphosed conglomerate, and breccia, not unlike what I have seen in Borrowdale, though it may have come from Binsey Crag, about three miles to the S.E. It measures 18 × 9 × 9 feet.

From Cockermouth to Loweswater.—To make sure that the syenitic boulders scattered over the country, from Lamplugh to the north of Cockermouth, and westward to a considerable distance, came from the high ground above Crummock Water and Buttermere, I walked to Loweswater from the N. W., and returned through the Vale of Lorton. I ascertained that the light grey and pinkish syenite must have come chiefly through the Loweswater gap, and that the reddish syenite, found abundantly about Cockermouth, must have come down the Vale of Lorton. But I was farther rewarded by the discovery of a drift-deposit, which seemed to be a connecting link between the pinel of the mountains and the reddish-brown Boulder-clay of the sea-coast. On a watershed between Mosser and Loweswater, there is a large flat plateau of Boulder-clay running into a cwm under Low Fell, and thinning out along the valley to the N. and down the slope to the S. It contains Skiddaw slate, apparently metamorphosed or baked slate, the latter very much rubbed and striated, grey porphyry, quartz, and light-grey syenite. The plateau lies about 400 feet below the summit of Low Fell, and about 400 feet above the level of Loweswater. It occupies a position in which it could never have been deposited, excepting by the agency of water and floating ice. This will appear from the sections, Figs. 23 and 24 in Pl. XXV.

From Cockermouth to Lorton.—The principal objects of interest near Lorton are the sand and gravel knolls on the roadside. A good section of the largest knoll, which is about 100 feet high, may be seen in a pit close to the road. The sand and gravel is extensively false-bedded, in a way that oceanic currents will alone explain. This knoll was once regarded as a striking specimen of a terminal moraine, and a scientific gentleman of the neighbourhood, who viewed it in this light, seemed somewhat vexed when I tried to convince him that it was a marine sand-bank (Pl. XXV., Fig. 26).

Sea-Coast at Workington.—The sea has exposed an extensive cliff-section of reddish-brown Boulder-clay. It is very hard, and contains many small stones, but very few boulders make their appearance above high water-mark. At its base, and on the adjacent beach, there are thousands of large boulders of several kinds of granite, dark whinstone, porphyry, breccia, sandstone, limestone, red syenite, etc. The clay is stratified (Plate XXV., Fig. 28), and shows rude indications of false-bedding. It is likewise vertically fractured. It is covered with thin beds of sand, surmounted by red loamy clay, with few stones. The clay contains patches of sand, as represented

Pl. XXV., Fig. 29. Further N., where the slope is partly vered with grass, the sand and upper clay seem to increase in ickness (Pl. XXV., Fig. 27).

Cleator Moor.—In a limestone quarry near the east end of the llage, I saw a considerable extent of surface nearly cleared of ddish-brown boulder-clay. Part of the surface was sea-worn into e most fantastic shapes, and part was glaciated. The striæ pointed between N.E. and N.N.E. The boulders I saw were chiefly light- loured syenite from Ennerdale, and a kind of hard trap.[1]

EXPLANATION OF PLATES XXIV. AND XXV.

[The classification adopted in the sections is provisional and may have to be altered, ough I believe that wherever two or more drift-deposits occur in vertical suc- sion, the order here assigned will be found to hold good; and though one drift- posit previously to the accumulation of another has often undergone extensive nudation, it is not presumed that each deposit was ever spread continuously over the hole of the area in parts only of which it is now to be found.]

PLATE XXIV.

G. 1.—1, bluish-grey boulder-clay; 2, yellowish-brown, reddish-brown, or variegated boulder-clay; 3, stratified sand and gravel; 4, upper boulder-clay and loam, generally reddish. A, 2, pinel on a hill slope, in one place underlain by pre-glacial screes, *a*; B, 2, pinel on a hill slope, replaced upwards by screes, *b*, and both covered with foxy-coloured loam, 4; C, 2, pinel on a hill slope, 4, loam overlying the pinel and running upwards into old screes *c*, *d* recent screes. These diagrams are intended to represent the most frequent mode of occurrence of drifts on plains and on mountain slopes in the Lake-District.

2.—Low-water tarn, under the summit of the Old Man, dammed back by a moraine.

3.—Glaciated rock-surface, in Church Beck Valley, Coniston.

4.—Split block, in Pudding Cove, Coniston.

5.—Glaciated rock-surface, S.E. of Windermere.

6.—Roche Moutonnée, partly covered with loam, near Windermere.

7.— Ditto, covered on upstream side with pinel and loam.

8.—Laminated pinel, near Ellerlay.

9.—Beach of pinel, under a cliff between Troutbeck and Kirkstone.

10.—Section near Low Wood Hotel. S, massive slate; L, laminated slate; 2, fine pinel; 4, loamy clay.

11.—Section about a mile S. of Shap. L, Carboniferous limestone; 2, greyish-brown pinel, with granite and other stones; 3, reddish loam. [See paper on Shapfell Boulders, GEOL. MAG., Aug., 1870, Vol. VII., No. 8.]

12.—Section opposite Brougham Hall. 3, sand and gravel; 4, reddish clay with boulders, covered with vegetation.

13.—Section close to railway cutting near Stainton (Penrith). 2, reddish-brown boulder-clay; 3, stratified, waved, and false-bedded sand and gravel; 4, reddish, loamy clay.

14.—Section of Old Red Sandstone, at the foot of Ullswater.

PLATE XXV.

G. 15.—Section of Bowscale cwm and S. slope of Caldew valley.

16.—Theoretical section, from Doddick cwm (Saddleback) to the railway. P, pinel; 4, loam; 1, blue clay; 2, brown clay.

17.—Rough sketch of the Knotts, covered with syenitic blocks—Wanthwaite Red Screes or Clough Head behind.

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[1] This article has expanded to such unexpected dimensions, that a brief statement the results of several weeks' researches into the derivation and distribution of the anitic drift of West Cumberland must be reserved for a future number of the OLOGICAL MAGAZINE.

Fig. 18.—Section near Castle Head, Keswick. A, clay and soil with few stones; B, fine gravel; C, pinel; D, clay with a few boulders. These beds are interwoven with and rest on an unknown depth of sand, with oblique and waved lamination.
19.—Section near Grange. A, gravel; C, glaciated boss of rock running under river-gravel B. Aa, gravel partly covered with screes farther south.
20.—Section above Barrow. 2, pinel; 3, red loam.
21.—Pinel filling up hollows and insinuated into crevices of shattered rock in Barrow Wood, Keswick.
22.—Pinel, upstream side of a *roche moutonnée*.
23.—Section of plateau of boulder-clay between Mosser and Loweswater.—Low Fell on the E., a low ridge on the W.
24.—Cross-section of the above from N. to S.
25.—Mode of occurrence of drift in Coledale Valley; A, the upper limit of erratics.
26.—Section of a reputed glacial moraine, near Lorton, covered with vegetation.
27.—Coast-section of drift, near Workington. 2, reddish-brown clay, with many large boulders in the lower part; 3, sand and gravel; 4, upper red loamy clay, with very few boulders.
28.—Appearance of stratification and fractures in the reddish-brown clay in the above section.
29.—Mode of occurrence of sand in one part of the above reddish-brown clay. C, laminated sand; D, sand; A, clay, with boulders; B, clay, with small stones.
30.—Section of part of a limestone quarry, at Cleator Moor. A, surface nearly cleared of clay, with a few remaining boulders; B, sea-worn surface.

II.—On Italian Tertiary Brachiopoda.[1] (Part III.)

By Thomas Davidson, F.R.S., F.G.S., etc.

(Plate XXI.)

48. *Rhynchonella bipartita* (Brocchi), sp., Pl. XX., Fig. 1, 2, 3. *Anomia bipartita* (Brocchi), Conch. Foss. Subap., p. 469, pl. x., fig. 7, 1814. *Terebratula incurva* (Von Buch), Ueber Tereb., pl. ii., fig. 40, 1834. *Terebratula plicato-dentata* (Costa). Fauna del Regno di Napoli, p. 27, pl. v., fig. 4, 1851.

In his description, Brocchi does not fail to observe that this is a very variable species. It is more or less transverse or elongated, and while some specimens are entirely smooth, others present from two to four ribs near the front in both valves, and about a similar number on each of the lateral portion of the shell, but these ribs are short and do not seem to extend far in the direction of the beaks. The ventral valve is gibbous, with a well-defined fold, while in the dorsal valve the sinus is broad and deep. In Brocchi's typical form the shell is smooth, while to the more or less plicated specimens Costa has applied the specific name of *plicato-dentata*, but, as was well shown by Philippi (Enum. Moll. Sicil., vol. 2, pl. xviii., fig. 5, 1844), there exists every passage in shape between the more transverse and smooth specimens to those that are more elongated and plicated near their margin. *Rh. bipartita* is also stated by Meneghini and others to occur in the Middle (?) and Upper Miocene, as well as in the Older Pliocene. From the Miocene it is quoted by the last-named gentleman from Palazzo near Siena, Parlascio and St. Lorenzo in Tuscany, and by Brocchi from the Piacentino; while Philippi.

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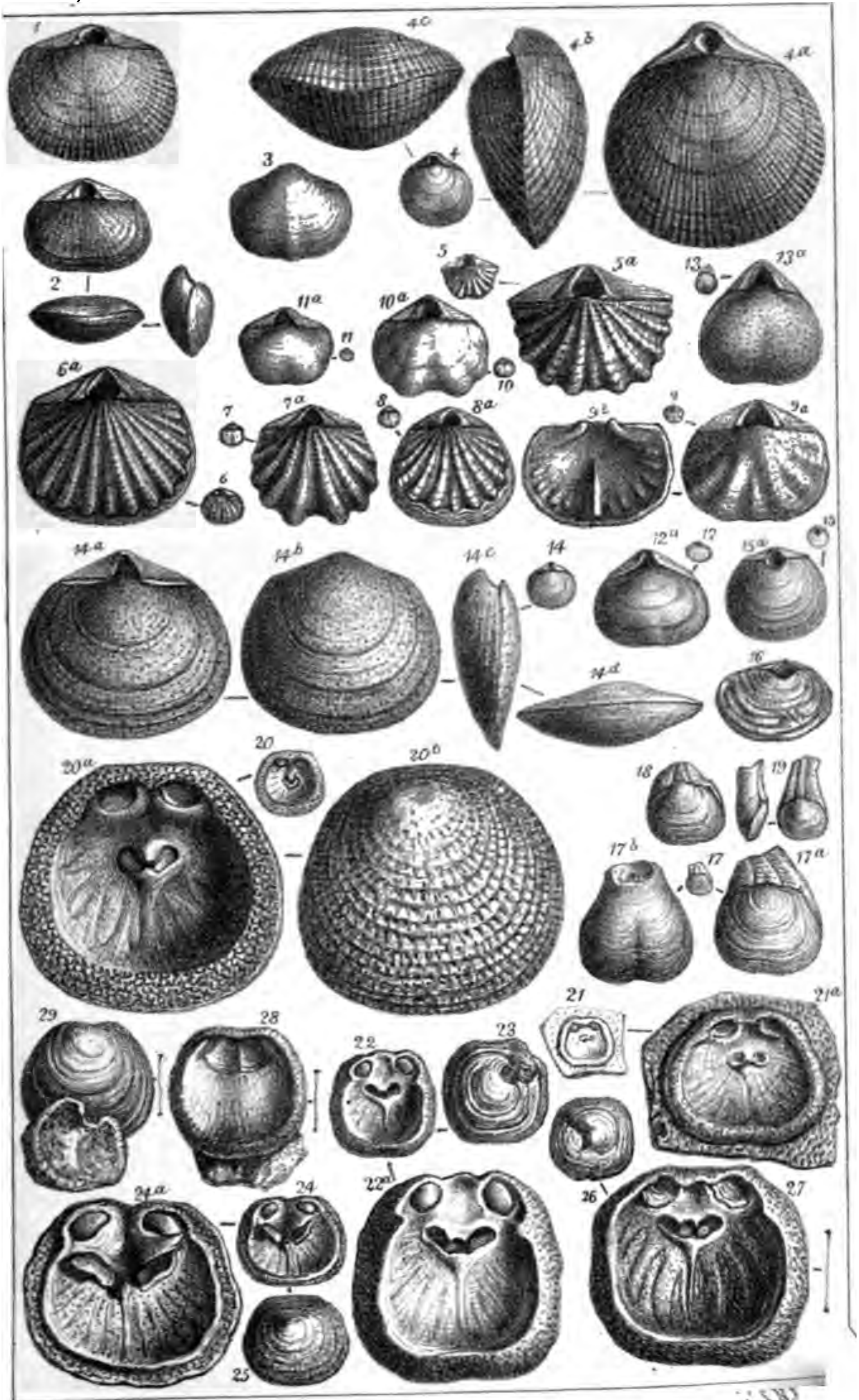
[1] Concluded from page 408.



Thos. Davidson del. & lith.

[illegible]

ITALIAN TERTIARY BRACHIOPODA.

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Costa, and Sequenza mention it from Altavilla near Palermo and Plemmirio, Fiumefreddo, etc., in Calabria. In the Lower Pliocene, it occurs at Orciano, Livorno, and Siena in Tuscany; in Calabria and in the district of Messina. It has been likewise collected by M. Gény at Beaumette, Nice; by Dr. Battersby at Biot near Cannes; and at Cerro di San Anton, Malaga, by Mr. Champernowne. I have also described specimens from the Island of Malta.

49. *Rhynchonella Bolcensis* (Massalongo), Pl. XX., Fig. 4 and 4*a*. *Ter. Bolcensis* (Massalongo). Schizzo Geognostico sulla valle del Progno o Torrente d'Illasi, etc., p. 18. Verona, 1850.

Shell small and smooth, somewhat obtusely five-sided, about as wide as long, broadest posteriorly, truncated in front. Ventral valve moderately convex, with a broad sinus commencing at about the middle of the shell and extending to the front; beak small, acute, and incurved; foramen minute. Dorsal valve most convex at the umbo, mesial fold wide and flattened, shell structure fibrous. Length 5, width 5, depth 2½ lines.

This little shell appears to be pretty constant in its shape and dimensions, and is a much smaller species than is either *Rh. decipiens* or *Rh. complanata*, and to which it bears some resemblance in form, but not in size. Sig. Massalongo states it to be very abundant in the Eocene at Bolca and Monte Spilecco. M. Bayan and Sig. Meneghini have procured it from the same localities. At Bolca it occurs in a small bed formed of a loosely aggregated greensand, with a peculiar local facies, and with it are found *Ter. Bayaniana*, *Rh. polymorpha*, and several other remarkable fossils.

50. *Rhynchonella complanata* (Brocchi), Pl. XX., Fig. 5. *Anomia complanata* (Brocchi). Conch. Foss. Subap., vol. 2, p. 469, pl. x., fig. 6, 1814; and Sequenza, Annali dell' Accad. degli Aspiranti Naturalisti di Napoli, third series, vol. 6, pl ii., fig. 3, 1866.

In external shape this species somewhat resembles an exceedingly flattened specimen of *Rh. bipartita*, but its frontal line is much more straight, and its fold and sinus considerably flatter. It is smooth, and when full grown attains to nearly the dimensions of the last-named species. Brocchi's figure does not convey a correct idea of the species, but it was subsequently well described and illustrated by Sig. Sequenza, and I am, moreover, indebted to Sig. Rovasenda for several excellent examples. It occurs in the Middle Miocene of Gassino near Turin. Brocchi's specimen was found near Pienza and St. Dalmazio in Tuscany, and it is also said to occur in the Upper Miocene at Butera (?).

51. *Rhynchonella sicula* (Sequenza), MSS., Pl. XX., Fig. 6.

This remarkable species will be fully described and illustrated by Sig. Sequenza. It is triangular, broadest anteriorly, and tapering at the beaks. The valves are moderately convex and smooth, without either fold or sinus. *Rh. sicula* was found by Count Al. Spada and Sig. Sequenza in the Older Pliocene (Zancleano) near Messina in Sicily.

52. *Rhynchonella polymorpha* (Massalongo), Pl. XX., Fig. 14-19. *Ter. polymorpha*, N.S. (Massalongo). Schizzo Geognostico sulla valle

del Progno o Torrente d'Illasi, etc., p. 19. Verona, 1850. *Ter. contorta* (Schaft). Schauroth Verszeichniss der Verst. Herzogl Natur. Zu Coburg, p. 165, 1865.

This is a very important and exceedingly variable species, and its correct identification offers certain difficulties, and especially so when we compare it with a similar-shaped shell from the Miocene to which Sig. Michelotti had in 1839 applied the specific designation of *Buchii*. Some palæontologists would seem inclined to unite the two into a single species, while others would appear disposed to retain them as distinct. *Rhynchonella polymorpha* is so variable, that two or three so-termed species might be made out of its different shapes did we not possess all the intermediate and connecting links. It is very irregular or inequilateral, and is either a little wider or shorter than long, broadest anteriorly, tapering at the beaks, and has always one half of each of its valves twisted indifferently either to the right or to the left, so that one half of each valve is near the front either higher or lower than the other; no regular median fold or sinus exists, the frontal line being during half its length convex and elevated, or bending suddenly downwards by a rapid curve. The beak is angular, with a small circular foramen under its extremity, which is surrounded and more or less widely separated from the hinge-line by a deltidium. The surface of the valves is in some specimens entirely smooth, while in other examples five or more short angular or rounded ribs occur in the vicinity of the margin on the one half of the shell only, the other half remaining smooth, but in other individuals both sides of the shell possess these ribs, while the posterior half of the shell is usually smooth. The largest example I have seen measured ten lines in length by six in depth.

Through the kindness of several friends I have been able to assemble a large number of the Eocene *Rh. polymorpha* and of the Miocene *Rh. Buchii*, so that I was able to select from them the very instructive series of specimens figured in our plate. I believe it will be seen from these drawings that if not specifically identical, it is highly probable that *Rh. Buchii* is a regular descendant, with small modifications due to time and altered circumstances, of the more ancient *Rh. polymorpha*, and that the Miocene shell much more rarely presents the short ribs which are so often met with in specimens of Massalongo's species. It may, therefore, be advantageous to preserve the two designations. Sig. Meneghini is of opinion that the shell mentioned by Alcide D'Orbigny under the designation of *Rh. Zignodiana*, and erroneously placed by him into his Terrain Callovien (Prodrome, vol. 1, p. 343, 1850), is a synonym of the species under description, as is likewise the case with the *Ter. contorta* of Schaftault, which was figured and illustrated by Baron Scharauth in 1865, but erroneously referred by him to the Cretaceous period. M. Mortillet describes *Rh. polymorpha* as a *Terebratula* approaching *Rh. incurva*.[1] Dr. Oppel has, likewise, described and illustrated a Jurassic species under the designations of *Rh. alta* and var. *polymorpha*,[1] which greatly resembles the Eocene *Rhynchonella* under description, but M. Bayan informs me Dr. Benecke has followed these beds (described by Oppel) into the Tyrol, but did not meet with the *Rh. alta*, although he mentions *T. gerda*. These beds would apparently be separated from those containing Massalongo's *Rh. polymorpha* by the bed with *T. diphya*, as well as by all the Cretaceous formation, and it is hardly possible to believe that the *Rh. alta* and *Rh. polymorpha* could belong to the same species, although some specimens of Oppel's shell may bear some resemblance to certain Eocene ones. *Rh. polymorpha* was noticed by Baron de Zigno in 1858.

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[1] Terrains du versant Italien des Alpes, comparés a ceux du versant Francais. Bull. Soc. Géol. de France, second series, vol. 19, p. 892.

Rh. polymorpha was found by Sig. Meneghini at Bolca and Breonio, in the Vicentin, where, according to that able palæontologist, as well as M. Bayan, it may justly be referred to the lowest portion of the Eocene, since it occurs in a bed overlying the Scaglia or Chalk of the Italians. M. Bayan has collected it from his stage A, at Monte Spilecco, near Bolca, and in the Val degli Strangellini, at Novale or the Zovo di Castelvecchio (Zovo being a Venetian patois designation, or corruption of Giogo, *jugum*). It has also been found by Sig. Meneghini in the Nummulitic beds of Brescia.

53. *Rhynchonella Buchii* (Michelotti), Pl. XX., Fig. 8-13. *Rh. Buchii* (Michelotti). Brevi cenni d'Alcuni resti delle classi dei Molluschi Acephali e Brachiopodi. Annali delle Scienze del Regno Lombardo-Veneto, p. 23, 1839, and Faune Miocène de la Haute Italie, p. 77, pl. ii., fig. 25, 1847. *Rh. deformis* (Sequenza). Annali degli aspiranti Naturalisti di Napoli. Third series, vol. vi., pl. iii., fig. 3, 3*a*, 1866.

In the preceding description we have already referred to this species, which does not appear to quite attain the dimensions of of *Rh. polymorpha*. Its valves are likewise generally smooth; short ribs on one half of its valves being of rare occurrence, and I have not yet seen them on both halves of the shell. It was from a crushed example of one of these exceptional specimens (Fig. 13) that Sig. Sequenza formed his *Rh. deformis*, but which name will, for the reasons above given, require to be placed among the synonyms of *Rh. Buchii*. According to Michelotti this species would occur in the Lower, Middle, and Upper Miocene. In the Lower Miocene it is found at Chiampo, in the Vicentin, but this stage would, according to some geologists, form part of the Upper Eocene, and the shell may consequently, perhaps, be a variety of *Rh. polymorpha*. In the Middle Miocene it abounds at Grangia and Termo Foura, in the hill of Turin, and it is from there that Sig. Rovasenda procured the fine series of specimens figured in my plate. It is found likewise at Sciolze and Callessione, near Turin. In the Upper Miocene at Altavilla (Michelotti).

54. *Rhynchonella Meneghiniana* (Dav.), Pl. XX., Fig. 7.

Shell small, globular, nearly as wide as long, with about twelve or thirteen ribs on each valve; beak small, incurved; valves convex, fold and sinus apparent only close to the front. Length 4, width 4, depth 3 lines.

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[1] Ueber das Vorkommen von jurassichen Posidonomyen-Gesteinen in den Alpen, p. 208, pl. vi., fig. 1. 1863.

Of this species I have seen but one example, which had been found by Sig. Meneghini in the Nummulitic, or Eocene of Bolca. It is entirely distinct from any of the other Italian species of its genus.

55. *Crania Bayaniana* (Dav.), Pl. XXI., Fig. 20, 20*a*.

Shell small, orbicular, broadest and rounded anteriorly, slightly converging and nearly straight posteriorly; ventral valve attached by a portion of its shell to corals, Bryozoa, etc.; dorsal valve slightly convex, sometimes much flattened, apex sub-marginal; external surface covered with numerous prominent concentric ridges, from which rise numerous small adpressed spines. In the interior there exists a widish granulated border with four muscular impressions, the central pair in the dorsal valve being divided by a nose-like prominence. Length and width about 4 lines. Some little uncertainty seems still to exist as to the Eocene age of the bed containing this small *Crania*. It would, according to Dr. Suess and Mr. Bayan, correspond to the beds of Biarritz, which these geologists would consider to be superior, or to overlie the Calcaire Grossier of the Paris Basin. *C. Bayaniana* was found by Mr. Bayan, at the Bucca di Sciesa, near Brendola, and at Lonigo (Colli Berici), and if the specimen attached to a coral (fig. 21, 21*a*) belongs to the same species, it would occur likewise at Crosara (along with *Thecidium Mediterraneum*), in the upper portion of Mr. Bayan's stage F.

56. *Crania abnormis* (Defrance), Pl. XXI., Fig. 22-27. *C. abnormis* (Defrance). Dic. Sciences Nat., vol. ii., p. 312, id. F. W. Hoeninghaus, Monog. der Gattung Crania, p. 13, pl. i., fig. 13, 1828. *C. Hoeninghausii* (Michelotti). Acephali et Brachiopodi, p. 6, and Foss. Mioc. de l' Italie Sept. p. 79, pl. ii., fig. 27, 1847. *C. Rugosa* (Sequenza). Piedmontese Brachiopoda. Annali dell' Accad. degli aspiranti Naturalisti di Napoli. Third series, vol. vi., pl. ii., fig. 4, 1866.

The interior of both valves of this *Crania* have been well described and figured by Hoeninghaus, Goldfuss, and others, but the exterior of the upper valve only seems to have been illustrated. In 1866 Sig. Sequenza had received from Sig. Rovasenda, of Turin, some lower valves of a *Crania* which appeared to him to differ so much from the upper valves of *C. abnormis* that he felt tempted to propose for these last the specific designation of *rugosa*. During the winter of 1868, Sig. Rovasenda sent me a large series of upper valves of *C. abnormis*, as well as several specimens of Sequenza's *C. rugosa*, and I became at once impressed with the idea that this last was no other than the attached valve of Defrance's species. In order to test the accuracy of this view, I obtained, through the kindness of M. Charles Des Moulins, of Bordeaux, and of M. R. Tournouer, of Paris, some authentic specimens of the attached valve of *C. abnormis*, derived from the Faluns of Terrenègre, near Bordeaux (Étage Tongrien d'Orb), the locality from where Defrance's specimens had been obtained, and I at once found that I had been correct in my anticipation, namely, that the French examples would entirely agree with those termed *rugosa* by Sequenza. The lower valve of *C. abnormis* is exceedingly thick and irregular, and attaches itself to submarine objects by a small portion of its shell, while the remaining part is roughly concentrically striated or grooved (Fig. 23 and 26). *C. abnormis* abounds in the Middle Miocene at Grangia, Termo Foura, Sciolze and Callessione, in the Hill of Turin; also at a place termed L'Ospitzio di St. Colombano, in the plains of Lombardy, at six miles from Lodi. The upper valve of this *Crania* is very common, but the attached one is found in much less abundance.

57. *Crania lamellosa* (Sequenza), Pl. XXI., Fig. 28, 29. Sicilian Brachiopoda, pl. viii., fig. 8, 1865.

When Sig. Sequenza described this species he was in possession of one attached valve only, but since then he has found several specimens of the upper or unattached valve, which he will describe and illustrate in his forthcoming new work on the Tertiary Brachiopoda of Southern Italy. *C. lamellosa* occurs in the Upper Pliocene of San Filippo, near Messina.

58. *Crania turbinata* (Poli), Vol. II., p. 189, Pl. XXX., 1791. Sequenza, Sicilian Brachiopoda, p. 75, 1865.

I have never seen any fossil Italian specimen of this species. It is described, but not figured, by Sig. Sequenza, and is stated to occur in the Quaternary deposits of Gravitelli and Trapani, near Messina, and is alive in the Mediterranean.

I have now completed my brief review of Italian Tertiary Brachiopoda, and have, I believe, sufficiently shown how numerous and interesting are the species that occur in that peninsula. It is more than probable that some few of the so-termed species enumerated in our list, when better known, will require to be added to the synonyms of some of the others; and I hope that before many years will have elapsed, that Italian Palæontologists will have enriched science by the publication of a complete monograph of the Tertiary Brachiopoda of Italy.

EXPLANATION OF PLATE XXI.

FIGS. 1, 2. *Megerlia truncata.* (Linné.) 1. Pliocene, near Messina. 2. Middle Miocene, Grangia, near Turin.
3. *Megerlia oblita* (Michelotti), Middle Miocene, Hill of Turin, after Michelotti.
4. *Megerlia ? orbicularis* (Meneg.) MS., Upper Miocene, St. Dalmazio, Tuscany, from unpublished drawings by Sig. Meneghini. 4 *a*, *b*, *c*, enlarged.
5. *Argiope decollata* (Chemnitz), Pliocene, near Messina. 5*a* enlarged.
6, 7, 8. *Argiope decollata* ? Eocene. Lower part of M. Bayan's stage F., Val di Scorvanto, near Brendola. Mus. of the School of Mines, Paris. 6*a*, 7*a*, 8*a*, enlarged.
9. *Argiope costulata* (Sequenza), Middle Miocene, Baldessero, Coll. of Sig. Rovasenda. 9*a* exterior enlarged. 9*b*. int. of dorsal valve enlarged.
10. *Argiope Neapolitana* (Scacchi), Pliocene, Siena. 10*a* enlarged.
11. *Argiope variolata* (Sold), according to Meneghini. Pliocene Siena. 11*a* enlarged.
12. *Argiope lunifera* (Philippi), *cistellula* (Wood), Lower Pliocene, Messina, after Sequenza. 12*a* enlarged.
13. *Argiope lævis* (Sequenza), Middle Miocene, Grangia, coll. of Sig. Rovasenda.

14. *Argiope? Rovasendina* (Dav.), Lower Miocene or Oligocene, Monte Sgreve di Sant Urbano. Mus. School of Mines, Paris. 14 *a*, *b*, *c*, *d*, enlarged.

15. *Platidia* (Morrisia), *anomioides* (Scacchi), Lower Pliocene, near Messina. 15*a* enlarged.

16. *Platidia* (Morrisia) *Davidsoni* (Deslongchamps), Quaternary, Trapani, Sicily; after Sequenza.

17–19. *Thecidium Mediterraneum* (Risso). 17. Lower Miocene or Oligocene, Monti Grumi di Castel Goberto. Mus. School of Mines, Paris. 17 *a*, *b*, enlarged. 18, 19, from Middle Miocene, near Turin, coll. of Sig. Rovasenda.

20. *Crania Bayaniana* (Dav.), Eocene? Bucca di Sciesa, near Brendola. 20 *a*, *b*, enlarged. Mus. E'cole des Mines, Paris.

21. *Crania Bayaniana*? Eocene, Crosara. Same collection.

22–27. *Crania abnormis* (Def.) 22. Attached valve. Middle Miocene, Sciolze. 22*a* enlarged; 23, exterior of same specimen, natural size; 24, interior of upper valve, Middle Miocene, Hill of Turin. 24*a*. enlarged; 25, exterior of same valve; 26, 27, exterior and interior of an attached valve, from Terrenègre, near Bordeaux.

28-29. *Crania lamellosa* (Sequenza), Pliocene, near Messina. Enlarged.

III.—ON THE CHALK OF THANET, KENT, AND ITS CONNECTION WITH THE CHALK OF EAST KENT.[1]

By GEORGE DOWKER, F.G.S.

THE Chalk from Cop-point, near Folkestone, to Walmer in Kent, has been so well described by Mr. W. Phillips, that I need do little more than allude to his paper,[2] in reference to the divisions of the Chalk in East Kent; but in a notice of the Isle of Thanet by the Rev. W. D. Conybeare,[3] this gentleman, from the absence of flints in the Chalk near Margate, was led erroneously to suppose it to belong to the lower division, and it was not till 1865 that this error was exposed in a paper on the Chalk of the Isle of Thanet by Mr. W. Whitaker, F.G.S., of the Geological Survey,[4] the latter gentleman pointed out the true position of the Margate Chalk, as that of the highest Chalk, and superior to that with numerous flints seen at Ramsgate; and he there remarked, "Very likely the Broadstairs Chalk will turn out to be the upper part of the 'Chalk with many Flints' (Phillips) of the cliffs from Walmer Castle to Dover Castle, and which is there the highest division;[5] so that the Isle of Thanet section would be the upward continuation of that given by Mr. Phillips."

Having in 1865 examined with Mr. Whitaker the coast-sections of the Isle of Thanet, and since that time made various comparisons of the Chalk of Thanet and surrounding neighbourhood, and having collected many fossils from the Margate Chalk, as well as the uppermost divisions of the Chalk shown in pits at Word, Eastry, Wingham, and Canterbury, it is my object in this paper to lay before this Society the conclusions I have arrived at.

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[1] Read before the Geologists' Association, May 7, 1870.

[2] Geological Transactions, vol. iv., p. 437.

[3] Geology of England and Wales, by the Rev. W. D. Conybeare and W. Phillips (1822), p. 90.

[4] Journal of the Geological Society, 1865, p. 395.

[5] The Geologist, 1863, p. 154.

It will be remembered that Mr. Phillips divides the Chalk, commencing with that between Walmer and St. Margaret's Bay into—

1st. Chalk with numerous flints 350 feet, divided into Chalk with few organic remains and beds of flint about two feet apart, and a bed of Chalk with numerous organic remains with peculiarly formed interspersed flints.

2nd. Chalk with few flints 130 feet, and between this and the last a thin bed of Marl, two or three inches thick.

3rd. Chalk without flints 140 feet. Between this and the last a soft bed of Marl; this is subdivided into a bed containing numerous beds of organic remains 90 feet, and a stratum about 50 feet with few organic remains.

4th. Grey Chalk estimated at not less than 200ft. This description applies to the coast section; inland between Walmer and Wingham, a bed of Chalk, superior to that seen in the coast-section, is met with, consisting of marly Chalk, with few flints, and this bed I take to be the representative of the Margate Chalk. This latter, described by Mr. Whitaker, is characterized by the absence of flints; the few found in it are not disposed in regular layers but scattered through the mass, and are apparently for the most part fossil sponges. This Chalk is very soft and marly, especially when wet, and makes superior whiting: occasionally very thin beds of flint occur obliquely. It is very much jointed at right angles to the plane of bedding, and the larger joints which are very marked and constant, run mostly in a north-west and south-east direction. The wearing away of the cliff along these joints forms a conspicuous and picturesque feature in the Margate Chalk, the joints being often traceable inland from atmospheric denudation having followed them. Besides the peculiar jointing of this Chalk it breaks up in drying into numerous smaller joints, and is very splintery, giving forth a metallic sound when struck with a hammer. This division of the Chalk may be 80 or 90 feet in thickness, and the upper portion has a peculiar ferruginous tint, owing to numerous organic remains in oxide of Iron. A short time since a well was sunk at Mr. Cobb's Brewery at Margate, which gave the following details. The well being in a valley all the upper beds were not present.

Chalk, without flints	30 feet,	Margate Chalk
Chalk, with numerous flints	265 „	
Rocky Chalk	19 „	
Blue Marl	3 „	

Beyond this the well was continued into Chalk, having few flints, depths not determined. It seems to me probable that the Rocky Chalk and the Blue Marl were the representatives of the bed described by Mr. Phillips as seen below Dover Castle. Mr. Whitaker in his paper on the Thanet Chalk showed the connection of the Margate or upper flintless Chalk with that at Broadstairs and Ramsgate, where a more flinty Chalk is seen. In the Cliff section the lower or flinty Chalk rises near Broadstairs, and dips again between Ramsgate and Pegwell Bay, where, from the presence of numerous small faults with a dip towards the south, the lower beds are rather suddenly brought to the sea-level, and beyond this, to Cliffs End, the upper or Margate Chalk again appears. The Isle of Thanet being in fact an elevated arch of Chalk, and the valley of the Stour, between it and the rest of Kent, a synclinal filled with Tertiary deposits. At Cliffs End, a junction of the Chalk and Tertiaries may be observed by the green-coated flints: I have elsewhere described these junctions.[1] Mr. Whitaker[2] considers the Thanet Beds to rest conformably on the Chalk and if so we should expect to find the highest beds of Chalk immediately beneath them.

In the Diagram illustrating this paper I have ventured to adopt a new nomenclature for the divisions of the Kentish Chalk. The divisions of Mr. Phillips occurring as they do at Dover, St. Margaret's, and at Ramsgate, I have preferred naming from the towns where they may be most advantageously studied. Commencing at Folkestone, the Grey Chalk (6) is easily recognised and is a term universally admitted. Next, the Flintless Chalk; (5) these two constituting the Lower Chalk. Next, the Chalk with few flints I have named Dover Chalk (4) (large *Ammonites* occur in it). The next division (3) of Mr. Phillips, which he calls a bed of organic remains with "interspersed flints," I call St. Margaret's Chalk (this bed is of a greyish appearance). The next bed, (2) that with "numerous flints in layers," Mr. Phillips has subdivided; I have classed it altogether as Ramsgate Chalk; this bed, which dips at Kingsdown, rises again in the Isle of Thanet, and is well developed at Ramsgate, where it constitutes the entire cliff; above this we have (1) the Margate Chalk. These divisions hold good as far as East Kent is concerned. Mr. C. Evans, in a paper lately read before this Society,[3] divided the Chalks near Croydon and Oxtead into Purley, Riddlesdown, Kenley, Whiteleaf, Warlingham, Morden, etc., beds, but without a knowledge of those cuttings I am unable to class them with the East Kent Chalk, nor do I believe much in the evidence of fossil zones, which he lays much stress upon. As far as palæontological evidence is concerned, it depends much on the lithological character of the Chalk in which fossils occur; for instance, large *Ammonites*, I will not say they are identical, occur in the Margate and Dover Chalks, separated by great thicknesses of Chalk, in which they do not occur, and over an extended area certain fossils are common or scarce in the same bed of Chalk. At various parts of the Chalk of the upper beds in the Isle of Thanet different fossils occur, and I have not attempted to draw any particular inferences from the fossil evidence until I have collected over a more extended area. But the fossils that occur in the Margate Chalk are most of them identical with those of the Norwich Chalk. I append a list at the end of this paper.

Mr. Prestwich has suggested that the highest Chalk under the Tertiaries of London belongs to the middle, rather than the upper

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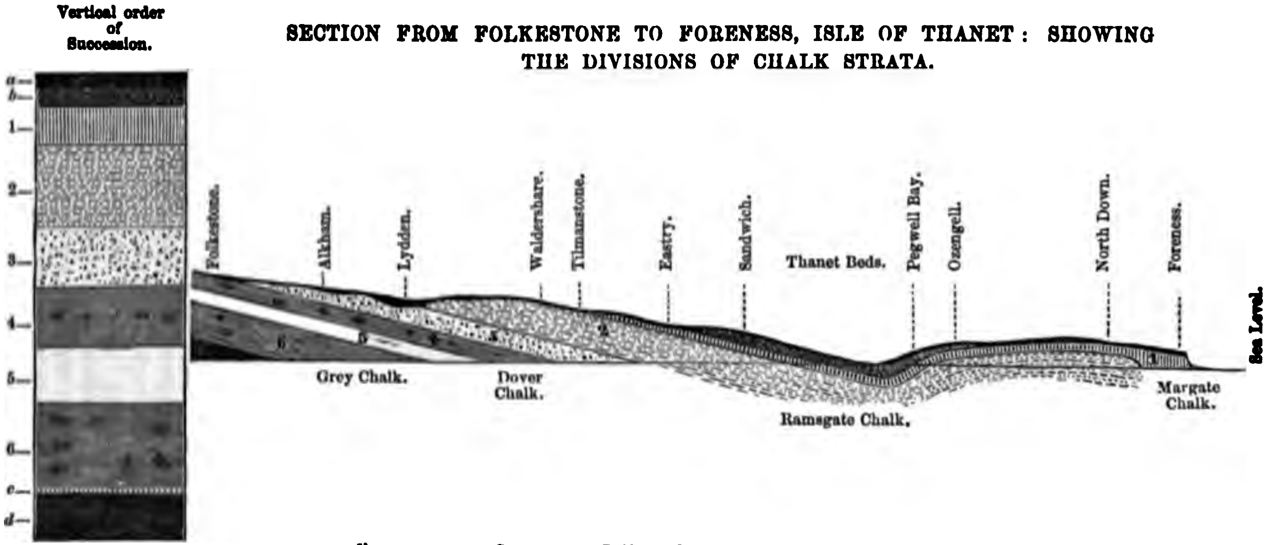
[1] Geological Magazine, Vol. III., No. 22, May, 1866.
[2] Quarterly Journal of Geological Society, 1865, p. 397.
[3] Proceedings of Geologists' Association, Jan. 7, 1870.

SECTION FROM FOLKESTONE TO FORENESS, ISLE OF THANET: SHOWING THE DIVISIONS OF CHALK STRATA.



EXPLANATION OF SECTION.—*a*. Drift. *b*. Thanet beds. *c*. Upper Greensand. *d*. Gault.
1. Margate Chalk. 2. Ramsgate Chalk. 3. St. Margaret's Chalk. 4. Dover Chalk. 5 Chalk without Flints. 6. Grey Chalk.

part of this formation.[1] He has arrived at this conclusion partly from the nature of the Chalk beneath the Tertiaries and its organic remains, and also from its total thickness. I would suggest, however, that the variations in the thickness of this deposit may not be altogether due to denudation of the upper beds, but to its having been deposited over an uneven sea-bed; for if the unequal thickness of the Chalk were due to its denudation, we should still find the Lower Chalk of comparatively the same thickness, which is not the case. Moreover, the Upper and Lower Greensand vary much in thickness. In 1855, Mr. Godwin-Austen gave reasons for supposing a possible elevation of the Coal Measures beneath the London basin;[1] and Mr. Prestwich's account of a well bored at Harwich confirmed this view.[2] If we compare the Chalk of Kent with that of Norwich and Diss in Norfolk, Lyme Regis in Dorset with the Chalk of Paris and the Isle of Wight, etc., we find that it is not always the upper but the lower divisions which have thinned out, as the following table will show.

A boring in the Chalk, lately undertaken to prove the thickness of the Lower Chalk between Dover and Calais, taken a quarter of a mile west of High Light, South Foreland, and four miles south-west of Calais, both below high-water mark, gave the following result:—

At South Foreland	175	Upper Chalk.
” ”	295	Lower ”
	470	

At Calais	270	Upper Chalk.
”	480	Lower ”
	750	

In the Isle of Wight Upper Chalk estimated	1200
White Chalk, without flints	200
Chalk Marl 60 to	80
	1480

NORWICH.	
Chalk, with flint, 6 or 7 ft. apart	483
Chalk, soft and yellow	10
Hard flints, 2 or 3 ft. apart	190
Chalk, without flint	350
Grey Chalk	102
	1135

DISS.	
Chalk, few flints, marly	100
Chalk flints, in layers	330
Grey Chalk, with flints	60
Blue Chalk	20
	510

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[1] Water-bearing strata of London (1851), p. 139.

[2] Journal of Geological Society, 1857, p. 249.

LYME REGIS.	
Chalk, numerous flints......	50
Do. flints not so numerous	50
Without flint	40
Ditto, green grains...........	25
	165

GRENELLE, PARIS.	
Chalk, with flints	1148
Lower Chalk...............	246
	1394

And the section at Harwich—Chalk, with flints 690
" " " Chalk, without flints 198
—888

It will be seen from the foregoing sections that the Upper Chalk prevails at Norwich, Isle of Wight, Paris, and Harwich, while the Lower Chalk at Dover, Calais, and Diss in Norfolk, which latter section presents a remarkable exception to the Norfolk Chalk, and appears to correspond with that of Margate. The absence of flint in the Chalk, or at least flint in tabular layers, may be owing to some lithological character of the Chalk, as soft Marly Chalk is generally destitute of flint. Mr. Tate, in a paper read before the Geological Society in 1864,[1] described the Upper Cretaceous beds of Ireland as equivalents of the Norwich Chalk, though they differ so much in lithological appearance that Conybeare referred them to the Lower Chalk. I observed last summer, during a visit to the Isle of Wight, that the Upper Beds of Chalk, at the junction with the Plastic Clay at Alum and White Cliff Bay, had a more Marly and soft appearance, and I obtained a few fossils corresponding with those from Margate. The Chalk at Gravesend and Northfleet though possessing more flints than the Upper Beds of the Isle of Thanet have many fossils in common, but on the whole I should consider it more like the Upper Beds of the Ramsgate Chalk. How far the Thanet beds may rest conformably on the Chalk it is difficult to determine, since we have no continuous sections, but the denudation of the Chalk, previous to the deposition of the latter, shows such an even junction in all the sections I have had the opportunity of observing, that it would seem to have been more a sub-marine than a subaerial action. At Alum Bay the junction of the Reading beds with the Chalk is even, (if we except the sand pipes) and marked by rounded pebbles in a ferruginous sand. In East Kent the fossils derived from the Chalk in the sand at the junction are characteristic of the upper division, *Ananchytes ovatus*, var. *pyramidatus;* and *Galerites albogalerus*, var. *tumidior* being very constant.

Of the fossils from the Margate Chalk I have several specimens of large *Ammonites*, one nearly three feet in diameter. It corresponds nearly with the *Ammonites leptophyllus*, only it possesses no ribs or undulations on the surface. Another specimen resembles *Ammonites Lewesiensis*, figured in the Palæontographical Monograph. I have also casts in flint of two other species.

A small *Belemnite* is very abundant; also a small distorted *Ostrea*. The fossils have been collected from the following localities:—Margate (I am indebted to Mr. Wetherell for several small fossils from this locality); Sarr, Thanet; Pegwell Bay, Thanet; Eastry; Word; Wingham; and Canterbury.

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[1] Quart. Journ. Geol. Soc., vol. xxi., p. 19.

I offer the following list of fossils as open to some correction, and I might add to the species could I determine the names of all the fossils. I leave others to draw their inferences from the Palæontological evidence, but it is clear that the Margate Chalk may on this be correlated with that of Norwich; and I am of opinion that on lithological evidence we may assume the Kentish Chalk to be as high, if not higher, than that of Norfolk.

The section of Chalk from Folkestone to Foreness accompanying this paper is an ideal section, the heights above the sea-level given as accurately as I have been able to estimate them, and the names of places on the section as approximately as I could place them without pretending to absolute accuracy.

LIST OF FOSSILS FROM THE MARGATE CHALK.

Named from Morris's Catalogue.—C. common, M.C. moderately common, R. rare.

AMORPHOZOA.

Brachiolites labyrinthicus ? R.
Cephalites Benettiæ.
Choanites Königii, M.C.
Coscinopora globularis, C.
——— *lævis*, M.C.
——— *pileolus*, M.C.
Manon osculiferum, R.
Siphonia Morrisii ? R.
Spongiæ.—Various species.
Ventriculites alcyonoides, M.C.
——— *flexuosus ?* R.
——— *infundibuliformis*, R.
——— *radiatus*, M.C
——— *Townsendi*, C.
Foraminifera (species undetermined).

ZOOPHYTA.

Parasmilia centralis, R.
——— *cultrata ?* R.

ECHINODERMATA.

Marsupites lævigatus, M.C.
——— *ornatus*, C.
——— *Milleri*, C.
Ananchytes ovatus, C.
——— *conoideus*, C.
——— *pyramidatus*, M.C.
Cidaris clavigera, R.
——— *sceptrifera*, M.C.
Cyphosoma corollare, R.
——— *Königii*, R.
Galerites albo-galerus, C.
——— *tumidior*, M.C.
Micraster cor-anguinum, C.
——— *gibbus*, R.
Oreaster Boysii, R.
——— *pistilliformis*, M.C.
Pentacrinus, R.
Echinopsis pusilla ? R.

ANNELIDA.

Serpula plana, *R.*
——— *plexus*, M.C.
——— *vortex*, M.C.

BRYOZOA.

Alecto gracilis, R.
Atagma papularium, R.
Diastopora ramosa, R.

BRYOZOA.—continued.

Marginaria Rœmeri ? R.
Pustulopora pustulosa, M.C,

BRACHIOPODA.

Crania costata, R.
——— *Ignabergensis ?*
——— *Parisiensis*, M.C.
Magas pumila, C.
Terebratula carnea, M.C.
——— *semiglobosa*, C.
Kingena lima ? (Davidson) R.
Rhynchonella octoplicata, C.
——— *plicatilis* (small variety), R.
——— *subplicata.*
Terebratulina gracilis ?
——— *striata*, C.

LAMELLIBRANCHIATA.

Exogyra auricularis ? R.
Inoceramus undulatus, C.
——— (species undetermined).
Lima granosa ? R.
——— *Hoperi*, C.
Ostrea inæquicostata,M.C.
——— (small species), C.
Pecten æquicostatus, R.
——— *Dujardini*, M.C.
——— *nitidus*, M.C.
——— *subinterstriatus*, R.
Spondylus Brightoniensis, M.C.
——— *spinosus*, M.C.
——— *fimbriatus ?* M.C.
——— *latus.*
Chama inæquirostrata ? R.

CEPHALOPODA.

Ammonites leptophyllus.
——— (large species, unknown).
Belemnitella mucronata, M.C.
——— *quadrata*, R.
——— } *sp.* C.
} 2, *subfusiformis?* D'Orbigny

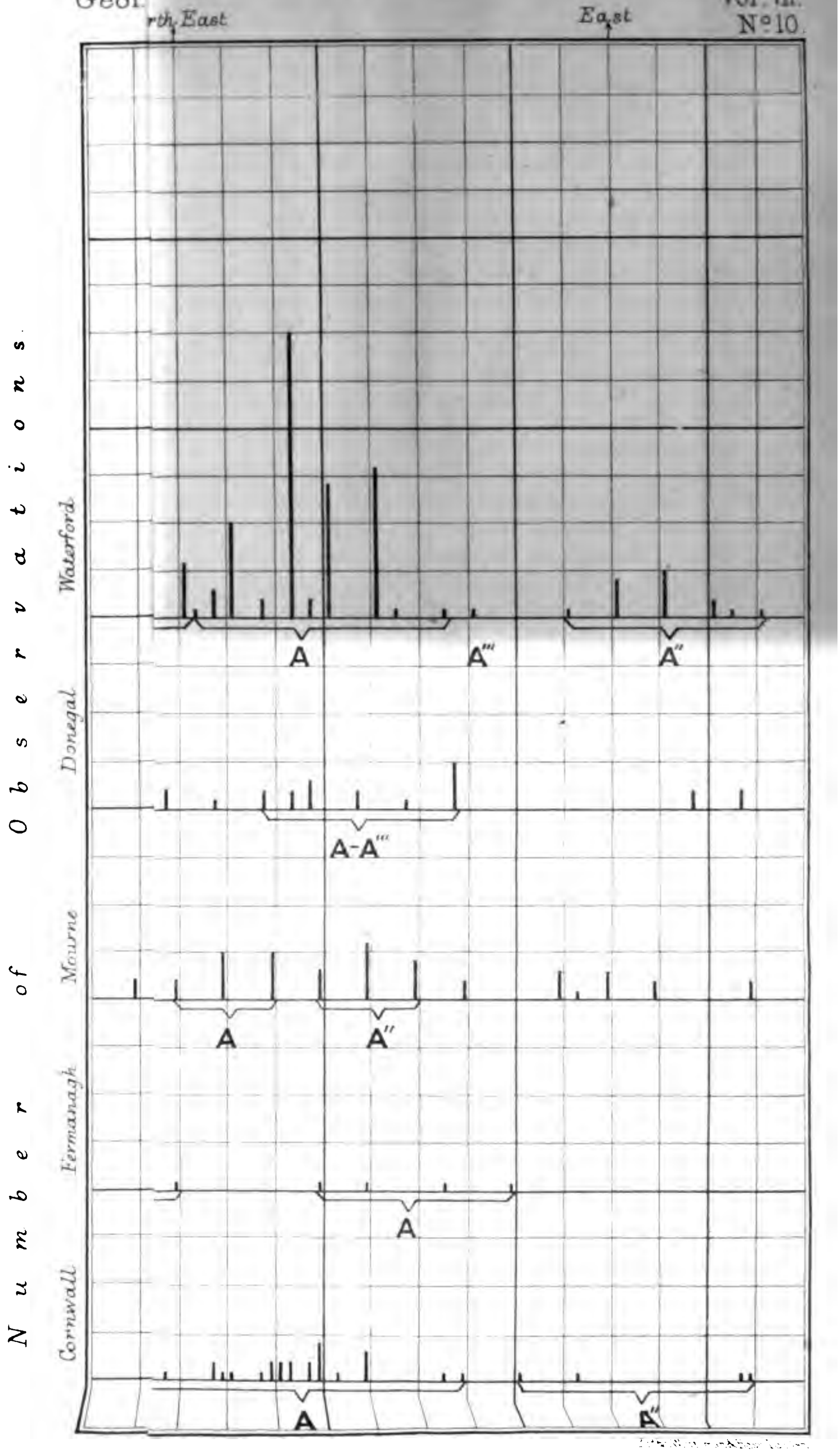
PISCES.

Remains abundant, but wanting teeth of Lamna, *Ptychodus*, *Otodus*; at least I have found no specimens.

Geol.

Vol. VII.
No. 10.

Planes.



lts in strata

IV.—ON FAULTS IN STRATA.

By HENRY B. MEDLICOTT, B.A., Geological Survey of India.

(WITH A DIAGRAM.)

SINCE I first saw my short notice on "Faults in Strata" in print (GEOLOGICAL MAGAZINE, 1869, Vol. VI., p. 341), I have been anxious to remove a blemish of apparent flippancy in alluding to *systems* as applied to faults. I had indeed in view cases where that method had been used imitatively—with the tacit assumption of an established and well-understood meaning; but I lost sight of the fact that serious special work had been devoted to the subject, and my remark was unqualified. I have to thank my friend Mr. W. T. Blanford for an opportunity of making this correction, as well as of adding some further considerations on so important a point in the principles of stratigraphy.

In his short answer to my paper (GEOL. MAG., 1870, Vol. VII., p. 115), although Mr. Blanford says he differs from me in opinion, it is very gratifying to me to find that there is far more agreement than disagreement between us upon the fundamental points at issue. Firstly, Mr. Blanford seems to grant that dips are unreliable as proofs of faulting. This admission might have removed the surprise expressed that my objections had not been answered, for all the special instances I impugned were of this nature. No one can doubt that faulting is attended by more or less bending of the strata, and such as, if strictly analyzable, would give a correct account of the mechanical action; but it can no longer be matter of opinion that dips of every form and degree are produced at the contact of rocks without any attendant faulting; and there is no mode of discriminating the causes in the effects. In this difficulty the importance of the direct evidence of the contact is not, I venture to maintain, to be underrated. Mr. Blanford's limitation of possible error from this source to small and unimportant cases is based upon the independent evidence (of straightness) which he conceives always to attend great faulting; on any other grounds this restriction could not be made, for the simulation of disturbance takes place on every scale, as, for instance, in the examples I brought forward from the Sub-Himalaya and the Garo Hills, where the throw, on the supposition of faulting, would amount to many hundreds, or even thousands, of feet.

On another most important point, that of the direct evidence, Mr. Blanford gives me all the satisfaction I could have expected. He says, indeed, that he has not, as a rule, noticed signs of friction in sections of undoubted faults in mines or cliffs; but it is not stated that he had looked for them; and as he now only endeavours to show cause for the removal of such marks, it may perhaps be inferred that there is a presumption of their having been always to some extent produced originally. That this evidence varies greatly in degree is certain: thus, Mr. Mammat in his "Geological facts to elucidate the Ashby Coal-field," in describing the characters of faults, says, "The two sides of the fault are generally so crushed in slipping as to resemble a mirror; and for the most part the space between the sides consists of coal, stone, and clay, ground to powder." That great faulting can take place without scoring it is difficult to imagine. It was only in support of this point that I alluded to glacial scratchings; being quite aware of the wide differences between the two cases. Thus Mr. Blanford's first objection to the comparison is rather irrelevant to any point at issue, as it only accounts in the usual way for the scarceness of good contact-sections—a fact of which I have had most wearying experience. The second objection, showing why slickensides should be very generally destroyed in faults, as compared to glacial friction surfaces, is slightly overdrawn: some of the best glacial scorings I have ever seen were on ordinary limestone[1] that had been exposed to the various modes of surface or sub-surface weathering since the Glacial epoch. Nor is it, I think, a general opinion that the action of deep underground percolation is more destructive of form than atmospheric agents; it is on the contrary often eminently preservative, by substituting hard pseudomorphs of what may have been originally in a very perishable condition.

There is, however, no doubt that in many cases very strong direct mechanical evidence of faulting has been preserved, enough (independently of the contrary evidence that may be thus elicited) to require some notice of the contact in every case of an asserted boundary fault.

It is not, I think, implied in my paper that this direct evidence is the only, or an indispensable, proof for faulting: it is even shown that this evidence may be most deceptive as to the amount of throw. I thought it unnecessary to state that my paper had reference only to the special point of contact-phenomena. There are several other considerations connected with faulting to which I did not allude; among them, that of straightness, upon which Mr. Blanford lays so much stress. That I fully recognize the importance of this character is sufficiently shown by the fact that I have mapped and described conditionally as great faults, and chiefly on this evidence of straightness, several features in the Sub-Himalayan rocks (Mems. Geol. Survey India, vol. iii., p. 134, etc.). I should still prefer to reserve the word *direct* for the character of the contact: it is incomparably the simplest, the most self-evident, and the least ambiguous; the appearance described in the passage I have quoted could only be produced by faulting. There is no other kind of evidence of which such an exclusive statement could be made; no one would affirm that a sharply curved or a zig-zag fault is impossible—it is a question of form, in which many conditions are involved. On the other hand, I believe that Mr. Blanford has overstated the case against the occurrence of straightness in orographical features; and that, therefore, this character of straightness, as well as that of dips, is liable to be simulated in natural boundaries. As an instance, I may quote from

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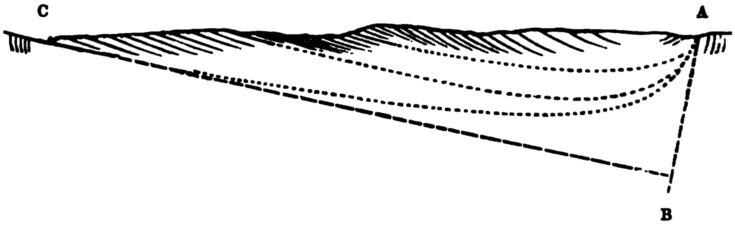
[1] Hard Carboniferous Limestone surfaces may frequently be seen in the North of England and in Scotland; beautifully glaciated, but the glaciated surface has usually been protected by a covering of drift or vegetable soil. We should doubt their preservation on soft rock if exposed for long periods to the weather.—EDIT. GEOL. MAG.

Mr. F. R. Mallet's description of the Vindhyan rocks (Mem. Geol. Survey India, vol. vii., p. 106), "The escarpment of the Kymon range, which faces the same for more than 200 miles between Rotasgarh and Bilheri, is nearly a straight line for the entire length without any indentation except the curve at Bidjigarh." Other instances might be given, though of less extent, from the Rajgir and Ghidaur hills. The word *straight* is quite as strictly applicable here as to the coal-measure boundaries; but it is right to note that the latter are in gneissose rocks. In steep ranges, formed along a steady strike, transverse drainage-cuts are apt to be few and narrow: when to such considerations we add from the other side the broken nature of the observations upon which geological boundaries must often be mapped, and that such interruptions and concealments would be most likely to coincide with original indentations of the boundary, I certainly must consider it a safe and necessary principle, rather than a false one, to require some reference to the evidence of the actual contact. No one would question the fact of a fault if he believed the feature to be in fact as straight as it appears when drawn with a ruler on a geological map. But every field geologist knows how rarely it is possible really to vouch for this, so that, unless corroborative evidence is given for a fault, it is difficult for any one who understands the possibilities of error, to accept the feature as demonstrated. I cannot but feel that on the principle here advocated my colleague and I are really at one.

In objecting to my example from the Garo Hills, Mr. Blanford again slightly departs from the special object the case was used to illustrate, viz., the widely different inferences to be drawn from the partial and from the full observations of that single section; without the examination of the contact at that spot, the practice most in vogue amongst geologists would, from the rest of the evidence, assume a fault, and place it at the contact; whereas the contact-section clearly proves that there is no fault there, and as clearly suggests that the great relative movement took place by flexure. No one would consider the question of the whole boundary finally settled upon the evidence of a single section; nor would any one apply the evidence of a clear contact-section to others, unless there were agreement of the more general and easily observed features. It is, on the other hand, admissible to give its full weight to all the evidence in hand; and it would be an unwarrantable restriction to our practical rules not to admit one clear section as a clue in the interpretation of several obscure ones of the same general feature. The evidence of straightness, upon which Mr. Blanford would still introduce a master-fault here, would be in such a case doubly liable to error, for flexures are by their nature as liable to the law of straightness as faults are. Professor H. D. Rogers, who paid so much attention to the details of stratigraphy, went so far as to say that all faults are upon broken flexures. And it must be noted that the natural boundary exposed by the flexure in question is a floor, not an edge, of deposition; and may be a "plane of marine denudation," thus escaping from the veto Mr. Blanford would place upon straight natural boundaries. A description of my observations in the Garo and Khasia Hills has lately been published (Mem. Geol. Survey India, vol. vii., pt. 1), and it may be noticed what confirmation the view taken of the Garo section receives from the observations of the same feature in the Khasia district, where many clear sections are exposed, exhibiting continuously the great flexure of the strata from the high level of the plateau to the very base of the range (compare sections on pp. 154 and 193).

There is another important stratigraphical character affecting indirectly, but in a very marked manner, the question of faulting. Most of us receive our first impressions of stratigraphy from diagrams and models, and it need not be argued how tenacious first impressions are. The type thus implanted might be called the sandwich, or the bread and butter type of stratification; and, however correct it may be for the very small sections in which it is exhibited, it becomes, as generalized by the green mind, a serious misrepresentation of nature. Thus from such surface indications as those given in the figure (see Woodcut), the unchecked bread-and-butter principle would at once



To illustrate the case of an *assumed* fault, where only a natural boundary (A) exists.
(A.B.C. assumed Fault).

suggest a fault at (A.) the right-hand boundary. If there were any apparently suggestive circumstances, such as an obscure junction, or comparative straightness of the boundary, there would be no escaping the inference, and the full section given would be that represented by the broken lines of the figure (A.B.C.); whereas a stricter examination of the evidence might reduce the features to the more natural cast represented by the curved dotted lines. If such a mistake could occur in this simplest condition of the case, what are not the risks of error when the compression has been very great? As I have already got into sufficiently hot water in search of examples, I must leave the reader to cater for himself.

The word *system*, as applied to features of direction in stratigraphy, will recall pre-eminently to every geologist the illustrious name of De Beaumont. It seems at first sight strange that an important theory—so elaborately worked out, brought forward with the required circumstances of an inductive discovery, steadily maintained by accomplished (although perhaps prejudiced) authorities, with a fair display of accruing verifications (see "Rapport sur les Progrès de la Stratigraphie," par M. L. E. de Beaumont. Paris, 1869),—should not have received adequate examination at the hands of some competent critic, by a full and impartial comparison with reliable observations. There are, no doubt, self-evident objections to the theory as it stands, such as the repeated recurrence of disturbance along the same lines of fissure at remote intervals of time; or, the production of intersecting fissures by one and the same force. There is even room for ridicule in the paternal weakness with which almost irrelevant phenomena are attempted to be affiliated and entangled in the cords of the *réseau pentagonal* by its venerable author. But such *critique de tendence* may be left to those who have only words to discuss; what is wanted is to know how much truth there is in this great idea—whether in geological or in primitive times (for men are returning to a belief in a primitive earth), great phenomena of disturbance were subjected to any recognizable law of form; and whether in order of succession these resulted in any symmetry of distribution, pentagonal or otherwise. It may indeed be that the very complexity and elasticity of this system, admitting perhaps of its being framed and supported by a plausible amount of evidence, through its adaptability to almost any evidence, should present a corresponding difficulty to any sufficient refutation; so that we may have to leave it to time to settle its merits. This is at least a convenient opinion for those to adopt who have neither the power nor the opportunity to undertake a full discussion of the subject. And it is no small consolation for such humbler workers to know that the intelligent observation of rock-structure in the field is the most useful way of contributing to the solution of those great problems. It was in this sense that I ventured, in my former paper on faults, to give warning against the temptation to an easily secured semblance of finish by systematizing structural features according to direction, without a due preliminary investigation of the other more essential characters—the special and the local significance of the things so classified.

I will attempt to illustrate the meaning and force of my remark by a brief discussion of the recent endeavour, on the part of a distinguished British geologist, to give an independent value to the element of direction. Professor Haughton's studies on joint-systems and their mechanical origin (Phil. Trans. for 1858 and 1864) are more searching than the wider system of De Beaumont; they take up details of structure that the latter author apparently found convenient to overlook. The speculations are based upon the discussion of a large collection of data, and are altogether most instructive; but in so far as applicable to practice they seem to me vague and uncertain; by which I mean that they would scarcely, if at all, lighten the burthen of observation to be undertaken in the investigation of a new field, by enabling one to draw any safe inference upon the more easily obtained evidence.

The leading facts of this inquiry have long been familiar to observers:—that in every region of disturbance certain directions of strike are predominant, and that disturbances are of different ages. The object of further researches has been to ascertain the limits of the various effects of disturbance, and to discover any order in them, or in the relations of the general systems to each other.

Professor Haughton's first and most completely worked example is taken from the patch of Old Red Sandstone on the coast of the county of Waterford. The rock covers an oblong area of about twenty-four square miles. Its most conspicuous variety is a massive conglomerate, some 200 feet thick, to which, for the sake of greater uniformity, all the observations were confined. Readings were taken of the bearings of 345 well-marked planes of fracture, whether joints or cleavage, faulted or unfaulted. When those readings are plotted, as in the accompanying diagram, no case being omitted, the great majority of them exhibit a marked natural arrangement, not only in single groups or systems, but these again showing a distinct distribution in pairs, in which the mean directions of the two groups are at right-angles, or conjugate to each other; forming together what Dr. Haughton calls a conjugate system. Two such double systems are conspicuously prominent, A C, and A′ C′: the A groups lie on either side of north-east; and the C groups on either side of north-west. Traces of two other conjugate systems, A″ C″, A‴ C‴, are discernible. There is, of course, an arbitrary margin in the demarcation of these groups: A and A′ have each a range of 25°, while for A‴ there is only a space of 12° left. It may be admissible that the range of effects of any force should be proportionate to the intensity of the action; but this variability would be a grave element of uncertainty when the systems were less marked than in the case before us.

The planes of cleavage, of jointing, and of faulting, are separately noticed. A platey or flaggy structure, varying from a quarter to four inches in thickness, was observed, having the direction of the group A, sometimes of A′: "now as the lines of greater force in a system of elevated beds must lie in the vertical plane, or nearly so, which contains the direction of the dip of the beds, and as the strike of the beds is intermediate between the systems A and A′, it is evident we have a close approximation to Sharpe's law," that cleavage planes are at right-angles to the direction of the greatest force. The aforesaid platey structure, therefore, represents cleavage, as formed in this conglomerate; and thus a key was obtained "to the explanation of the physical structure of the whole district," the direction of the main forces being ascertained. Dr. Haughton considers a more or less pliant condition necessary to the production of cleavage; and that the force which produced it was probably the first that acted upon these rocks.

The true joint-planes are at right angles to those of cleavage; and it is a characteristic of both that the hard pebbles of the conglomerate are cut clean across by them. In the case of the cleavage planes this is explained by the development of a latent cleavage even in the hard pebbles. The jointing is supposed by Dr. Haughton to have been produced by the shrinking of the consolidated rock-mass, consequent upon evaporation and drying, the planes being determined at right-angles to the lines of minimum force to which the rock had been subjected, and therefore conjugate to the cleavage planes.

There are other planes of fracture besides those of cleavage and of jointing. Of twenty cases of faulting, nineteen occurred in the groups A C, A′ C′; and one in C″. The chief dislocations are in the groups C and A′. "If we had no other evidence of the physical structure of the conglomerate than is supplied by the foregoing systems of faults, we should be entitled to conclude that two systems of elevating forces had acted, either simultaneously or in succession." "The planes of the elevating forces were probably vertical planes, nearly in the azimuths of 30° west of north, and 33° north of west." The conjugate system A C was principally concerned in producing the inner or latent structure; while the system A′ C′ was probably the most powerful. "Both were concerned in producing the elevation of the beds, which have an average strike of east 35° north, and an average dip of 13°.42 south. The strike of the beds is thus seen to be intermediate between the systems A and A′, but lying nearest to the former, which I conceive to have acted first in order of time." "From the discussion of the planes of structure not belonging to the two principal conjugate systems of the district, I feel little hesitation in coming to the conclusion, that there was at least one more system of forces at work in producing the final structure of the Old Red Sandstone conglomerate:" the system A″ C″ is represented by fourteen observations of planes having a mean strike of 6° south of east, and twelve planes bearing 5° east of north. There is one observation of a bearing east 15° north, the solitary representative observed of the bearing conjugate to that of C″, which is represented by six readings having a mean strike of north 15° west. "Although it is a single observation, I believe it affords evidence (although not strong) of the probable existence in this district of a fourth system of forces having acted upon the conglomerate beds."

The foregoing statements illustrate, in the author's own words, the conclusions he draws from the tabulation of his observations. It may be remarked that much of the exactness, especially as regards the minor systems, may be due to the arbitrary selection of the range of the single groups; thus, the single observation in A‴ is but 2° removed from the great group A; and three of the twelve observations in C″ are much closer to the group A′ than to the nearest reading in C″. These alterations would, however, only slightly affect the striking distinctness and correspondence of the two principal conjugate systems. But the chief observation to be made, with reference to the object of my paper, is upon the purely abstract nature of the inferences that can be drawn from the systems, as such: every properly geological inference (upon the magnitude, direction, and succession of the phenomena) is based upon independent evidence—the direction of upheaval of the strata, the throw of the faults, the theory of cleavage and jointing. The learned author of the paper is evidently not deceived on this point, for in speaking even of the two main conjugate systems on their own merits he says that the forces which produced them may have acted either simultaneously or in succession. An unguarded reader might, however, suppose that four "systems of forces" represented by four conjugate systems of fracture, indicated four periods of disturbance, instead perhaps of four main components of one great phenomenon of compression.

In the later paper (1864) Prof. Haughton develops his mechanical views more precisely. A number of new observations are tabulated from four localities—Donegal, the Mourne Mountains, Fermanagh, and Cornwall, and compared with those from Waterford. In none of the new regions, except perhaps Cornwall, is the natural grouping of the readings so manifest as in the example from Waterford; so of course there is more scope for arbitrary selection; when the bearings range pretty closely from pole to pole, the formation of conjugate systems is a simple process.

Looking independently at the Donegal observations, the most simple combinations of joints are—a Primary system having a range of 20°, and a mean bearing of 26° north of east; a Conjugate Primary having a range of 20°, and a mean bearing of 29° west of north; and a Secondary system with a range of 6°, and a bearing of 31° east of north. The latter is very nearly the bearing of the A system; and the two former when divided yield two, corresponding very closely with the systems A and C, and two representing the systems A''' and C'''. The Primary Systems of Donegal are therefore tabulated as (A–A'''), (C–C'''). It may be remarked that between the small groups A and A' in Donegal, there are observations disregarded, although well within the range of the corresponding systems in Waterford, and which if included, as one would think they should be, would make the agreement much less remarkable than it is pronounced to be.

In the Mourne region the joints are still more equally distributed from pole to pole; but six systems, each with a range of only 10°, are readily told off, and lettered according to the nearest groups of the original set, many observations being omitted.

The majority of the observations recorded in Fermanagh are readily included in five systems; having the relation of Primary, Conjugate, and Secondary. All the observations in Cornwall are also amenable to a similar order: the main conjugate system corresponding very closely to the system A C of Waterford.[1]

It might seem, from the persistent and somewhat forced manner in which the several systems are throughout ticketed in approximate correlation, that Professor Haughton attached some occult meaning to them, analogous to that pervading the De Beaumont theory: but such is not the case; the absence of such agreement, except in the A C system in Waterford and Cornwall, is expressly noticed. The object of the uniform lettering is to exhibit the data upon which the learned author bases his theory of Primary, Conjugate, and Secondary Joint-systems, having angular relations constant within narrow limits of variation. Tables xi. and xii. of the paper under notice exhibit these limits as deduced from the five series of observations. The slightly elastic method of selection of the several systems may have helped to the coincidences exhibited by the figures in those Tables; but on the whole they fairly support the interpretations put upon them.

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[1] These observations for Cornwall would seem to be very incomplete: in M. De Beaumont's recent work, already referred to, at p. 553, M. Moissenet gives a range of 60°, with a mean to E.N.E., for lodes of tin; a range of 60°, mean a little north of [illegible], for copper lodes; and a range of 50°, mean a little west of north, for lodes of lead.

The abstract statement of the theory is very intelligible: when a force acts transversely upon a stratified mass, it tends (by incipient folding or by cleavage) to produce fissures at right-angles to its direction; this is the system which (when discernible) would be called Primary. When a force again acts upon the mass thus fissured its effect will vary: if the component perpendicular to the Primary fissures predominates (a continuation of the first force would be altogether so), the first tendency will be to form cracks at right-angles to the first set, and to be called the Primary-Conjugate system. A continuance of this force, or a force having a predominant component parallel to the Primary fissures, will tend to produce fissures having angles with those systems, respectively dependent upon the coefficient of friction of the rock; thus forming what Dr. Haughton calls Secondary systems, oblique to the direction of the force; and which are in turn conjugate to each other.

Upon applying the known coefficients of friction of various rocks to the construction just stated, the range of variation of the angles is found to agree with that derived from observations between the several conjugate systems. Thus Professor Haughton has achieved a demonstration that rocks in undergoing fracture in the earth's crust are subjected to mechanical laws. "From this it follows that a single hypothesis as to the direction of a system of forces is sufficient to account for the existence of these conjugate systems of joints, involving six directions, and it also explains the rudely hexagonal jointing of many rocks, if the coefficient of friction be such as to render the angle θ nearly 30°." It is not clear to me how the original force, normal to A, can produce the conjugates to its two Secondary fissure-planes; but let that pass.[1]

In thus introducing an intelligible principle of order into a chaotic subject, Prof. Haughton has conferred a great boon upon field-geologists; but I fail to perceive the independent practical importance the author would attach to it. He concludes with this remark:—"Many other consequences flow from the preceding investigations, into which I have not time to enter, but which may be readily found and turned to practical use by the field-geologist who prefers one hypothesis to many." While paying field-geologists the compliment of supposing them as clear-sighted as himself, Prof. Haughton rather passes a slur upon their pursuit, by suggesting that their judgments are for the most part an arbitrary decision between hypotheses. The notion indicates appropriately the geological barrenness of the theory. These systems, manipulate them how we may, give one a very minimum of information upon the rocks. Because a conjugated system of fracture may have been formed by one and the same force, it does not at all follow in any particular case that they were so

[1] The possibility of widely discordant systems of fissures being produced by one and the same act of disturbance, as proved by Professor Haughton, seems completely to stultify such attempts as that of M. Moissenet to identify the fissures of a single locality with many distinct systems of the Réseau Pentagonal.

formed; and it would be rash in the extreme to come to any conclusion on the point without a close search for collateral evidence. Prof. Haughton has himself courageously given us an example of how to work his system independently, and to apply his rule of preferring one hypothesis to many. In a recent paper (Journ. Royal Geol. Soc., Ireland, vol. ii., p. 163, 1868–9) he takes up the lines of elevation described by Mr. Hull in the Carboniferous rocks of Lancashire (Quart. Journ. Geol. Soc. Lond., April, 1868) as forming a simple illustration of his system of Primary Conjugate and Secondary joints—"an easy consequence of the same system of forces acting upon that district, and by no means necessitating the hypothesis of distinct sets of forces for each system of faults or axes." The system of forces that produced the Lancashire axes acted in a north and south direction, causing first the Pendle or Primary axis of elevation; secondly, the Pennine, or conjugate axis of elevation; and, lastly, the lines of fracture or Post-jurassic system of joints. Thus the observed geological order of occurrence of these systems, determined by Mr. Hull, coincides with the order that might have been predicted from the action of mechanical forces."

Now, a brief reference to another paper of Mr. Hull's (Quart. Journ. Geol. Soc., Lond., 1864, vol. xx., p. 242,) describing the Pennine range, will show that the north and south joints in that range are only subordinate features in a great system of flexure, which would, according to the universal practice of geologists, and according to the rule used by Professor Haughton himself in his paper on Waterford, be referred to the action of an east and west system of forces, and perfectly inexplicable by a north and south force.

I can only repeat my caution against the too rational as well as against the irrational use of *systems*.

While thus freely criticizing Dr. Haughton's work, I do so with misgivings. My respect for his intellect and for the powerful instrument he is master of, is so great, that I am quite prepared to be demonstrated in error. However, having studied his papers with all the light that is in me, I feel pretty sure that a large majority of geologists would take the view I have taken; and I am willing to be victimized, that we may all learn.[1]

11, HASTINGS STREET, CALCUTTA, 30 *July*, 1870.

[1] In Mr. Medlicott's former article on "Faults in Strata," the following errata escaped correction (see GEOL. MAG., vol. VI., 1869). Page 341, line 13 from commencement of article, for 'experimental' read *experienced;* second line from foot of same page, for 'implicit' read *explicit*. Page 342, line 21 from foot of page, for 'having' read *leaving;* line 20 from foot same page, for 'instance' read *evidence*. Page 343, line 3 from foot of page, for 'lose' read *box* ("box the compass"); last line same page, dele 'such.' Page 344, line 10 from top of page, for 'marks' read *modes*. Page 345, line 26 from foot of page, for 'equivalents' read *equivalence;* same page, line 7 from foot, for 'run' read *seen;* same page, line 5 from foot of page, for 'their' read *thin*. In justice to the 'Reader,' we beg to explain that the Author's MS. of this article (in 1869) was in a handwriting *exceedingly difficult to read*. It is always desirable that illegible articles should be recopied before they are sent to the printer, as it saves numerous errors. This is especially the case where the author, from his residence abroad, is unable to read and correct his own proof sheets.—Edit. GEOL. MAG.

NOTICES OF MEMOIRS.

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I.—Geological Survey of Ireland.

Explanation to accompany Sheet 95 of the Map of the Geological Survey of Ireland, including the country around Headford and Oughterard, illustrating parts of the counties of Galway and Mayo. By G. H. Kinahan, and J. Nolan, 1870. 8vo. pp. 71.

THE authors first draw attention to the Physical Geography of the area. A considerable portion of it is occupied by Lough Corrib, the second largest sheet of fresh-water in Ireland. This is only twenty feet above the mean sea-level in Galway Bay. The southern portion of Lough Mask enters the map at the north-west, its surface is thirty-six feet higher than that of Lough Corrib, into which it flows by subterranean passages. The "rock basins" in which these lakes lie, present appearances which suggest their having been excavated at the same time, and by similar denuding agents.[1]

The area is in general hilly, the highest point, Benlevy, reaches 1,370 feet. The rivers in the low country east of the lakes were formerly, for a great part, subterranean, but some years since artificial cuts were opened that now carry off the greater part of the drainage, although in no case has the water ceased to flow in the subterranean channels.

The formations noticed in the area under consideration consist of:—

Alluvium, Bog, and other superficial coverings.
Drift or Glacial deposits.
Carboniferous Limestone.
Carboniferous Sandstone.
Upper Llandovery.

Igneous and metamorphic rocks are also met with. The former include Greenstone, Hornblende rock, Felstone, and intrusive Granite; the latter comprise Quartzites, Gneiss, Crystalline Limestone, Schist, and Serpentine.

The authors[2] give a brief general description of the rocks, and then proceed to describe in detail the geological structure of the country, dividing it for convenience into four districts, namely, the Oughterard district, the Headford and Cong district, the island in Lough Corrib, and the Benley and Kilbride district. The drift and other superficial deposits are noticed in a separate section, and after them the Mines and Mineral Localities.

The Irish Granite has been divided by the Rev. Prof. Haughton into two distinct classes—intrusive and non-intrusive. All the granite in this area seems to be intrusive, it is termed the "Oughterard Granite," from its being so largely developed in the neighbourhood of that town. Its usual constituents are quartz, orthoclase, white and black mica, and frequently iron-pyrites. It is occasionally traversed by mineral lodes, particularly lead lodes.

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[1] See paper by G. H. Kinahan "On the Formation of the 'Rock-basin' of Lough Corrib," Geological Magazine, Vol. III., 1866, p. 489.

[2] The parts furnished by both authors are specified in the 'Explanation.' The country was surveyed chiefly by Mr. Kinahan.

Attention is directed to the foliation of the metamorphic sedimentary rocks, which seems to have been predisposed to follow the most marked structure in the original rocks. Simple or parallel lamination, apparently, was the principal structure of the ancient rocks of the district, so generally the foliation is parallel to the bedding. Curled or spheroidal foliation likewise is present, which in some cases seems to have been caused by the original rock containing nodules. Other forms of foliation are pointed out.

The Silurian rocks, supposed to be the equivalents of the Llandovery beds, consist of green and grey grits, sandstones, and shales, many of which are fossiliferous; with, near the base of the formation, red and purple shales, sandstones, and conglomerates.

The Carboniferous rocks are also described, and their fossils noticed, in the account of the districts where they occur.

The Drift-deposits seem to belong to three distinct classes; the first being the true Boulder-clay, a slightly sandy clay, in which are embedded beautifully polished, scratched, and rounded blocks and fragments of rock; the second, Boulder, or Moraine-Drift, consisting of broken and sub-angular fragments and blocks of local rocks (rarely polished), mixed with sandy clay; and the third, Esker-Drift, or "Post-Drift" gravels and sands. The first and third occur on the low country west of the lakes, and the last seems to be the Boulder-clay washed or sifted, as it is found merging into a Rocky-drift, or half-washed Boulder-clay, and from that into the Boulder-clay itself. The second occurs principally in the valleys, or on the slopes of the mountainous district. A similar drift in Wales, is supposed by Professor Ramsay to have been formed by the glaciers that once existed in its mountain valleys. That such glaciers did also exist here appears probable, as will be seen in the table of ice-striæ given in this "explanation."

The relations between the form of the ground and its internal structure are alluded to. At least three great periods of disturbance and denudation are considered to have affected the country from early geologic times down to the Glacial epoch. The most ancient of these was that which affected the metamorphic and granitic rocks, as on the east of Benlevy the Silurian rocks were deposited in places against a cliff over 200 feet in height. The second was that during which a great part of the Silurian rocks and also parts of the older rocks were carried away. The third period of denudation was that in which so much of the Carboniferous rocks was excavated and carried away, as to leave the features of the country to a great extent as it is now found. This may have been partly due to marine action, but the last great agent at work would seem to have been ice, as all the rock-surfaces which are protected from the "meteoric abrasion," now in progress, are well polished, planed, and striated; moreover on the exposed surface of the country, the authors have noted the rounded flowing outlines which are now universally recognized as the result of ice-agency. Since the ice has disappeared the existing denuding agencies have been, and are daily, at work, slowly and gradually changing the features of the country. Adjoining the lakes, they remark, the weathering seems to be much more rapid than elsewhere. They mention that on the granite near Oughterard the decay, since the Glacial period, appears to be from half to one and a half inch, judging from the height the unweathered veins, traversing the granite, stand up above the mass of the rock.

The authors give an account of the Mines, more particularly those of Glan, Oughterard, and Glengowla; they also mention the ores obtained from them.

The "Explanation" is illustrated with several woodcuts, and it has moreover the advantage of a good index.

II.—THE CARBONIFEROUS FORMATION OF SCOTLAND.

AT the Meeting of the North of England Institute of Mining and Mechanical Engineers, held at Glasgow, and extending over four days, August 9 to 12, Mr. JAMES GEIKIE, District Surveyor of the Geological Survey of Scotland, read a paper on the Geology of the Carboniferous formation of Scotland. The author described, first, the Calciferous Sandstone series, which, when typically developed, consists of two groups of strata, the lower pointing to the prevalence of marine conditions during the deposition of the Red Sandstones and conglomerates, and the upper showing that, during its accumulation, marine and brackish water conditions alternated with the occasional appearance of land surfaces. Volcanos were somewhat prevalent during the deposition of both groups. Secondly, he noticed the Carboniferous Limestone series, consisting of a lower group indicating marine conditions and occasional old land surfaces; a middle group indicating frequent land surfaces, and alternate brackish water and marine conditions; and an upper group pointing chiefly to marine conditions, with occasional brackish water-deposits and a few old land surfaces. Both submarine and subaerial volcanos were active during the deposition of this series. Thirdly, he drew attention to the Millstone Grit, which was deposited under almost exclusively marine conditions. Fourthly, he described the Coal-measures, which show a prevalence of brackish or freshwater conditions, with abundant land-surfaces, and with evidence also of occasional inroads of the sea. Mr. Geikie then pointed out that there were intrusive rocks of three classes, namely, some referable to the close of the Coal-measures; bosses or pipes of tuff or agglomerate, probably of Permian age; and dykes of Dolerite of Miocene Age. Two systems of faults of different ages were indicated, the older striking north-east and south-west, the other a double-set, striking approximately east and west, and north and south. In conclusion Mr. Geikie referred to the exceeding richness of the variety shown by the phenomena of the Scottish Carboniferous formation, and said he had no hesitation in affirming that, when the palæontological and geological histories of these rocks was thoroughly worked out there would be prepared one of the most important chapters in the physical history of the country.—*Nature*, 25th August, 1870.

REVIEWS.

DISTRIBUTION OF THE CEPHALOPODA IN SILURIAN COUNTRIES.

By JOACHIM BARRANDE.

(Extrait du Syst. Silur. du Centre de la Bohême. Vol. II. 4me série, pl. 351-460.)
Prague, 1870. 8vo. pp. 480.

WE have already directed the attention of our readers to M. Barrande's great work on the Cephalopoda of Bohemia. (See GEOL. MAG. 1866, Vol. III., p. 32, and 1867, Vol. IV., p. 322.) In the present volume M. Barrande has prepared, with the most laborious care, a summary of the whole of the vast array of facts and details relating to the geographical and geological range of the Cephalopoda in Silurian countries, and presents us with his deductions therefrom.

M. Barrande excuses himself for the space which he has occupied in the consideration of the Cephalopoda, by showing how vast was their geographical range in Silurian times, and also because they represented (if we except the scanty remains of fishes in the older palæozoic rocks) almost the highest class of living organisms. In the earlier Silurian stages (Fauna II. of Barrande), the Cephalopoda were certainly the dominant class, and it was only towards the close of that great series of deposits that their reign was disputed by the earliest Fishes and the great larval-like Crustaceans of the genera *Pterygotus* and *Eurypterus.*

Upon the question of the comparative strength of the two classes, the Mollusca and Crustacea, when tested by the relative fecundity of the two groups, M. Barrande seems disposed to divide the palm between the Cephalopoda and the Trilobita, which appear to have been equally innumerable.

But in organization and in relative age, the Trilobita are preeminent. For in the Primordial zone (Fauna I. of Barrande), they represent nearly the entire fauna, whilst not a trace of the Cephalopoda has as yet been met with in these earliest stratified rocks.

In the Upper Silurian stages, the abundance of the Cephalopoda would lead one to expect that they would have been discovered in the Primordial rocks, but such is not the case at present, and it would appear that the Trilobita were really called into existence ages before the Cephalopoda. It is but reasonable, however, to assume that a great break in time exists between the Primordial Silurian and the Tremadoc rocks in which the Cephalopoda first appeared. When the relative numbers of the two great groups are compared, the difference is but very small, thus:—

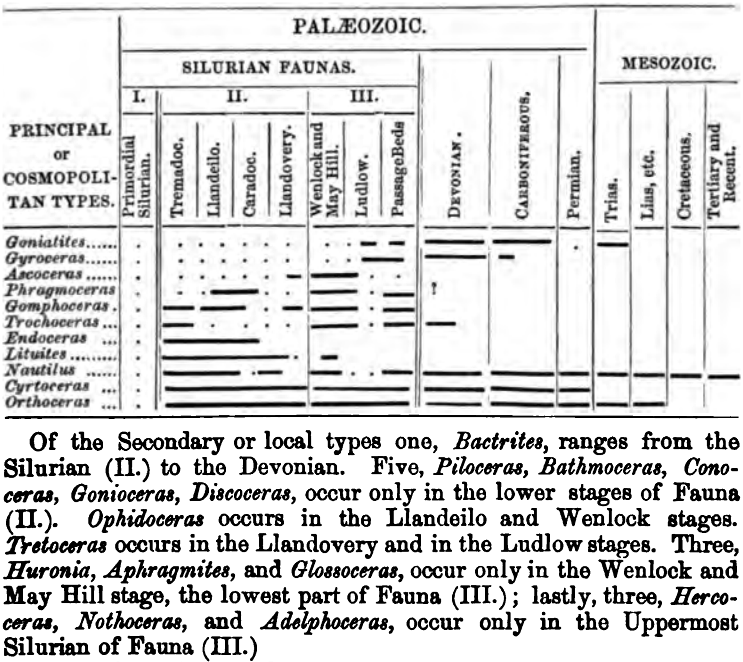
Total number of Trilobita,	1677	Including the Primordial zone.
Total number of Cephalopoda,	1622	From the second and third Silurian stages.
Difference,	55	

So that, assuming there may be 55 species of Trilobites found in the Primordial zone in the rest of the Silurian series, the hosts of the Cephalopoda equal those of the Trilobita.

In the first appearance of the Cephalopoda, it is interesting to notice that they are met with not only in widely separated geographical positions, but also in great generic and specific variety.

The total number of types in this class is 25, and of these 12 make their appearance in the earliest stage of their incoming. (See the following table.)

The subjoined Diagram represents the extension of the principal generic types of the order of the Cephalopoda which appeared during the Silurian period.[1]



Of the Secondary or local types one, *Bactrites*, ranges from the Silurian (II.) to the Devonian. Five, *Piloceras*, *Bathmoceras*, *Conoceras*, *Gonioceras*, *Discoceras*, occur only in the lower stages of Fauna (II.). *Ophidoceras* occurs in the Llandeilo and Wenlock stages. *Tretoceras* occurs in the Llandovery and in the Ludlow stages. Three, *Huronia*, *Aphragmites*, and *Glossoceras*, occur only in the Wenlock and May Hill stage, the lowest part of Fauna (III.); lastly, three, *Hercoceras*, *Nothoceras*, and *Adelphoceras*, occur only in the Uppermost Silurian of Fauna (III.)

In another table (too large to be reproduced here), M. Barrande shows the first appearance of the types, and he observes that in each principal region compared, there is a very great diversity both in the first generic appearance, and also in the numbers met with. Thus in Canada a small *Orthoceras* first appears at the base of the Calciferous sandstones; in England a small *Cyrtoceras* is found in the Tremadoc slates; in Russia eight different types are met with in the Orthoceras limestone; whilst in Bohemia seven types appear together in Bande *d* 1 of M. Barrande (or Tremadoc ?).

M. Barrande divides the Cephalopoda into three families, the *Goniatidæ*, the *Nautilidæ*, and the *Ascoceratidæ*. The first of these includes the genera *Goniatites* and *Bactrites*, the last *Ascoceras*, *Aphragmites* and *Glossoceras*, Barr., whilst the *Nautilidæ* includes twelve genera, embracing all the varieties of form of shell, from the straight *Orthoceras* to the perfectly coiled *Nautilus* and *Trochoceras*.

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[1] Taken from Barrande's work (p. 256).

The number of species derived from the twelve types of *Nautilidæ* is 165, representing about one-third of the 478 forms which characterize Fauna II. in all the Silurian countries.

Thus at the outset of this group we find it largely represented both in genera and species. About three-fourths of the 165 species mentioned above are found by M. Barrande to be extremely local; this would seem to contradict the idea of the free pelagic habits of these mollusca; there may have been, however, other impediments; for the world-wide homogeneous conditions of climate in Silurian times, is, after all, only an assumption, whilst land barriers may have opposed the migration of marine faunas, even more effectually than they do at the present day.

The following Table cannot fail to interest English palæontologists, giving as it does a summary of the British Cephalopoda.

	ENGLAND, SCOTLAND, AND IRELAND.	SILURIAN FAUNAS.								Total Appearances.	Reappearances.	Distinct species.
		I.	II.				III.					
		Primordial Silurian.	Tremadoc.	Llandeilo.	Caradoc or Bala.	Llandovery.	Wenlock and Mayhill.	Ludlow.	Passage Beds.			
	Number of types in each stage.		1	4	5	4	5	7				
1	*Cyrtoceras*, Golf.	.	1	1	7	3	2	4	.	18	3	15
2	sub. gen. *Piloceras*, Salt.	.	.	2	.	.	.	.	.	2	.	2
3	*Orthoceras*, Breyn.	.	.	6	23	15	18	19	.	81	25	56
4	sub.gen. *Endoceras*, Hall.	.	.	1	1	.	.	.	.	2	.	2
5	*Lituites*, Breyn.	.	.	.	5	2	.	1?	.	8	1	7
6	*Gomphoceras*, Sowby.	.	.	.	1	.	1	.	.	2	.	2
7	*Tretoceras*, Salter.	.	.	.	.	1	.	1	.	2	.	2
8	*Phragmoceras*, Brod.	.	.	.	.	.	3	3	.	6	2	4
9	*Trochoceras*, B.H.	.	.	.	.	.	1	1	.	2	1	1
10	*Ascoceras*, Barr.	.	.	.	.	.	.	1	.	1	.	1
	Appearance by stages.	.	1	10	37	21	25	30	.	124	32	92

Total appearances for each Fauna 69 55

Reappearances between different stages to be deducted 9 12

60 43

103

Reappearances between the II. and III. Faunas to be deducted 11

Total number of distinct British species... 92

We should take care to mention here that M. Barrande divides his geographical distribution of the Cephalopoda into three parts:—A. GRAND CENTRAL ZONE OF EUROPE, which includes Bohemia, France, Spain, Portugal, and Sardinia. B. GRAND NORTHERN ZONE, subdivided into I. EUROPE, Great Britain, Norway, Sweden, Russia, Thuringia, Franconia, Saxony, Germany, and Holland. II. NORTH AMERICA, Newfoundland, Acadia, Canada, New Brunswick, New York, Wisconsin and Illinois, Missouri and Tennessee. C. DIVERS COUNTRIES, consisting of the Himalayas and Tasmania.

After investigating the principal phenomena presented by the successive evolution of the Cephalopoda in the vertical series of the Silurian deposits, M. Barrande has endeavoured to ascertain how far that chronological evolution accorded with the zoological development of the group, and he then proceeds to draw a parallel between the two.

This concordance, M. Barrande observes, would be at once evident if the most simple forms appeared first, and the most complex last, in the series of Silurian rocks. The author maintains, however, that such is not the case.

Thus the most simple forms, the Ascoceratides, do not appear until the close of the second fauna in Canada, and at the commencement of the third fauna in Bohemia; whilst forms the most complex, such as *Nautilus* and *Trochoceras*, appear at the beginning of the second fauna in America, so that it would seem there was an interval of nearly the length of the entire series of deposits forming the second fauna of Barrande, before the appearance of the simple forms, during the whole of which period the more complex forms had existed.

These facts the author considers are sufficient to show that there is an irreconcilable discordance between the chronologic and zoologic evolutions.

M. Barrande considers that the total absence of Cephalopods in the Primordial Silurian strata does not permit us to suppose that the earlier types were developed during the existence of a hypothetical series of Anteprimordial faunas of which not a trace remains.

In replying to M. Barrande upon this point it is needful to be most cautious, for this reason, that he has gone so carefully into this grand question that it is hardly possible to find a flaw in the conclusiveness of his reasoning. We would, however, venture to suggest a few points deserving his attention.

And first as regards the regions explored. M. Barrande has probably achieved more, *single-handed*, in the country of Bohemia, for the exploration and investigation of its fossil fauna, than has been done by the united labours of many men for any other country in the world. The result speaks most eloquently from the pages of M. Barrande's great work. In the Cephalopoda which we are now considering, we find the number of genera and species enumerated from Bohemia alone to exceed that of any other region in the world hitherto explored.

The following list will express the relative numbers described from the various geographical regions enumerated in the work before us:—

		GEOGRAPHICAL AREAS OF THE SILURIAN CEPHALOPODA.	Number of Genera.	Number of Species.
A	1	Bohemia	20	979
	2	France, Spain, Portugal, and Sardinia... ...	4	35
B 1	3	England, Scotland, and Ireland	10	92
	4	Norway	9	33
	5	Sweden	7	35
	6	Russia	10	107
	7 8	Thuringia, Franconia, Saxony, the Hartz, Germany and Holland	7	75
B 2	9	Newfoundland	6	23
	10	Acadia	4	10
	11	Canada (Anticosti)	14	171
	12	New Brunswick	1	3
	13	New York	9	127
	14	Wisconsin	10	58
	15	Illinois	8	29
	16	Missouri	3	11
	17 18	Vermont, Michigan, Pennsylvania, Iowa, Minnesota and Arctic America	5	31
C	19	Himalayas	4	6
	20	Tasmania	2	6

A = Grand central zone of Europe.
B = Grand northern zone.
B 1 = European section.
B 2 = American section.
C = Divers countries.

A careful examination of the above elaborately worked out statistics of this group, published by M. Barrande, will show that exactly in proportion to the labour bestowed so is the result.

Thus we see that Barrande in Bohemia; Kjerulf and Angelin in Norway and Sweden; Strangways, Murchison, and Schmidt in Russia; Billings and Hall in America; and Sowerby, Salter, Phillips, Portlock, M'Coy and other palæontologists in England, have brought up the genera and species in these areas to the high total numbers we have indicated, and we may assume that, given an equally large number of ardent and earnest palæontologists in all the other Silurian countries, explored and unexplored, we might expect equally great results.

Taking however a geologically coloured map of the world, and contrasting the relative proportion of the Silurian areas already explored with the vast and unexplored regions yet remaining, we cannot but conclude, that after all, M. Barrande, like every other generalizer, has prepared his tables and based his results on the limited information we at present possess, and we may therefore fairly conclude that, however carefully prepared, these generalizations must necessarily be very imperfect. What, for instance, do we yet know of the Primordial Silurian forms to justify us in assuming that we shall not find Orthocerata in these rocks?

Nor should we, as zoologists, forget that the argument derived from the *shell* of a Mollusk, which is, after all, only the protective sheath, and not the animal itself, rests on very uncertain grounds.

The shells of the Palæozoic Cephalopoda may in some instances have been internal, and in others external, and the animals to which they belonged were perhaps widely separated zoologically. Nor is the simplicity or complexity of the shell a sure proof of its relative zoological position. The many-chambered shells of *Spirula* and the simple shell of *Argonauta*, both belong to the Dibranchiata, yet how widely different in structure. Some of the Palæozoic forms of shell, such as *Trochoceras*, *Phragmoceras*, *Gomphoceras*, *Ascoceras*, etc., may have been the internal shells of early Dibranchiates, *qui sait?*

Taking the Cephalopoda as a whole (not looking at Silurian forms alone), there can be no doubt of the concordance between the zoological and chronological records. For the later and higher forms are not the many-chambered Tetrabranchiata (represented in palæozoic times by the Orthoceratidæ, etc., and at the present day by the pearly Nautilus), but the active internal-shelled Dibranchiata, the Squids and Cuttlefishes, whose advent takes place in Neozoic times, long after the reign of Orthoceras had passed away.

In venturing thus to differ from so illustrious a Palæontologist as M. Barrande, we would not for a moment have it inferred that we desire in the least to disparage his grand work on the Cephalopoda of Bohemia, which, with his labours on the Trilobites of the same country, will remain the most lasting monument of his genius and industry; but we merely suggest that the results of future research may induce M. Barrande to alter his views on the question of evolution.

H. W.

REPORTS AND PROCEEDINGS.

THE DEVELOPMENT OF THE "KING-CRAB," *LIMULUS POLYPHEMUS.*

By A. S. PACKARD, Jun., M.D., Salem, Mass., U.S.A.

[Read before the American Association for the Advancement of Science. Communicated by Prof. C. H. HITCHCOCK, State Geologist of New Hampshire].

The following were the chief conclusions of the Author:—

THE eggs of *Limulus* are laid in great numbers loose in the sand, the male fertilizing them *after they are* deposited.[1] This is an exception to the general mode of oviposition in Crustacea; *Squilla* being the only other genus in which the eggs are not borne by the female until maturity.[2]

Besides the structureless dense irregularly laminated chorion there is an inner egg-membrane composed of rudely hexagonal cells.

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[1] In the higher Crustacea the eggs appear to be impregnated by the male before they leave the ovaries.—Edit. GEOL. MAG.

[2] Another exception is the Land-Crab of the West Indies, *Gecarcinus ruricola*, which is said to leave its home in the highlands of Jamaica, when the spawning season arrives, and march in a direct line towards the sea-shore for the purpose of depositing their eggs in the sand, the young *Gecarcini* being marine-dwellers until they have undergone their larval metamorphoses. Professor Bell, in his History of the "British Stalk-eyed Crustacea," p. 79, says, of the common Shore-crab (*Carcinus Mænas*), "Like most of the Brachyura, this species buries its ova in the sand."

This membrane increasing in size with the growth of the embryo, the chorion splitting and being thrown off during the latter part of the embryonic life. Unlike the Crustacea generally, the primitive band is confined to a minute area, and rests on the top of the yolk as in the Arachnida. The embryo is hatched as a *Nauplius;* it sheds its *Nauplius* skin about the middle of the period of its embryonic life. This *Nauplius* skin corresponds to the "larval skin" of the the German Embryologists.

Neither does the embryo nor the larva pass through any metamorphosis.[1] The larva differs from the adult in possessing a less number of abdominal feet (gill-feet), and in having only a very rudimentary spine.

Previous to hatching it strikingly resembles *Trinucleus* and other Trilobites, suggesting that the Trilobites are lower than the *Xiphosura,* and that the two groups should, on embryonic and structural grounds, be included perhaps in one order.

The inferior position of the Trilobite is also seen in the ovate body, like the early embryo of *Limulus,* the uniformity of the limbs and the broad sternal groove (described by Mr. E. Billings) and the embryonic abdomen.

The trilobate character of the body, as shown in the prominent cardiac region, and the well-worked (movable?) abdominal segments of the embryo, the broad sternal groove, the position and character of the eyes and ocelli, confirm this view.

Now that Mr. E. Billings has demonstrated that *Asaphus platycephalus* possessed eight pairs of legs[2] of uniform size, the Trilobites should be taken out of the neighbourhood of the Phyllopods and placed at least next to Xiphosura.

The organization and habits of *Limulus* throw much light on the probable anatomy and habits of Trilobites. The correspondence of the cardiac region in the two groups shows that their heart and circulation were very similar. The position of the eyes shows that the Trilobites had extraordinary long and slender optic nerves, and a general similarity in the nervous system. The reproductive organs of the Trilobites were probably very similar to those of *Limulus,* and the eggs were doubtless laid in the sand or mud and fertilized by the male after their deposition by the female. The ova probably filled the large cephalophorax, as in *Limulus.* No doubt the Trilobites possessed powerful muscles (as in *Limulus*), to enable them to burrow in search of marine worms, etc., and probably the alimentary canal gizzard and immense liver were likewise foreshadowed in this early prototype of *Limulus.*[3]

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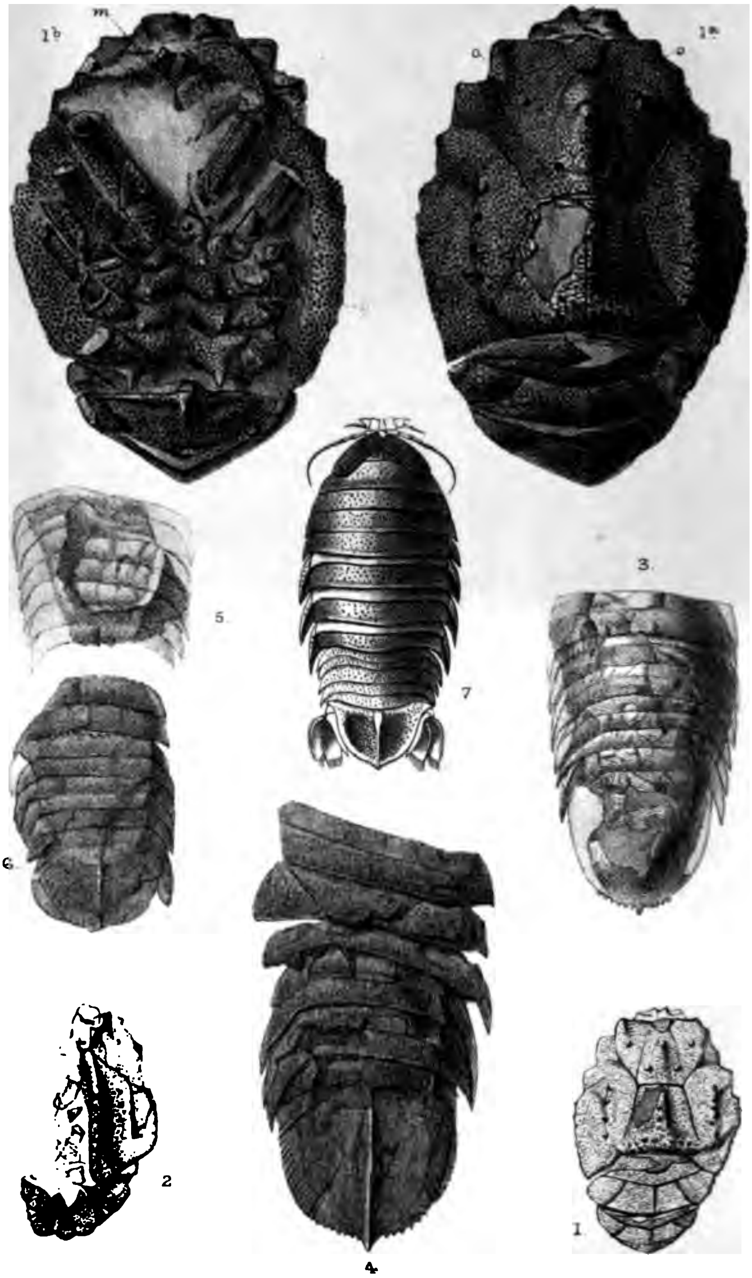
[1] This seems to be slightly misleading, since Dr. Packard's own statement speaks of important changes taking place in the larval king-crab before it arrives at the adult condition.—Edit. GEOL. MAG.

[2] See Report of Mr. E. Billings's paper, "Notes on some Specimens of Lower Silurian Trilobites" (read before the Geological Society of London May 11th, 1870) GEOL. MAG., 1870, Vol., VII., June, p. 291.

[3] See also an excellent article on "The Horse-foot Crab," by the Rev. S. Lockwood, Ph. D. in the *American Naturalist*, vol. iv., No. 5, for July, 1870, p. 257.



del. et lith.
W. West imp.

British Tertiary & Cretaceous Crustacea.

THE
GEOLOGICAL MAGAZINE.

No. LXXVII.—NOVEMBER, 1870.

ORIGINAL ARTICLES.

◆

I.—CONTRIBUTIONS TO BRITISH FOSSIL CRUSTACEA.

By HENRY WOODWARD, F.G.S., F.Z.S., etc.,
of the British Museum.

(PLATE XXII.)

VERY few deposits containing organic remains have yielded more beautiful Fossil Crustacea than our London clay formation. In evidence of this, one has only to turn to the beautiful series of plates which illustrate Professor Bell's Monograph, published by the Palæontographical Society (vol. x. 1857), illustrative of 15 genera and 19 species chiefly from the London area and the Isle of Sheppy.

Among the specimens which have lately come under my own notice, is a beautifully preserved example of the rare genus *Scyllaridia* of Prof. Bell, of which a single species, *S. Koenigii*, has been already described and figured by that gentleman.[1]

The Crustacean which is figured on Plate XXII., Figs. 1, 2, is much smaller than *S. Koenigii*, and when perfect, probably did not measure more than two and a quarter inches in length, and not quite an inch in the breadth of its carapace; less, in fact, than half the size of *S. Koenigii;* both the upper and under surfaces are preserved in a very good state, as may be seen by referring to the enlarged Figs. 1*a*, and 1*b*, in our Plate, most ably drawn by Mr. A. T. Hollick.

Having carefully compared the fossil, both with the original description and with specimens of *S. Koenigii*, I am satisfied of its specific distinctness; and in naming it I beg leave to pay a tribute of respect and regard to my friend, Professor Bell, of Selborne, to whom I am indebted for much kindness in past years.

Scyllaridia Bellii, sp. nov. (Pl. XXII., Figs. 1 and 2.)

Description :—Carapace very nearly as broad as long; finely granulated; frontal margin straight, equal in breadth to one-half the broadest part of the carapace; orbits occupying the latero-anterior angles of carapace, apparently less inclosed than in *S. Koenigii*, upper and inner orbital margin elevated; cervical furrow transversely dividing the cardiac and gastric regions near the

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[1] See Monograph Fossil Malacostracous Crustacea of Great Britain, by Prof. Bell, F.R.S., F.G.S., Part I., "Crustacea of the London Clay," 1857, pl. viii., figs. 1, 2, 3, Palæontographical Society's Monographs, vol. x.

middle of the carapace for about one-third of its breadth, then passing in an oblique direction outwards and forwards, reaching the lateral margin in a deep and broad depression behind the orbits; gastric region strongly ridged, having one large and very prominent median tubercle midway between the rostrum and cervical furrow and two small lateral ones; hepatic region marked by one central tubercle, margin indented; cardiac region with a strong median ridge, ornamented with numerous small tubercles along its most elevated part; branchial region ornamented down the centre by a raised line marked by from four to five tubercles, border slightly tuberculated; basal joints of antennules small; those of external antennæ broad and flattened, as in other genera of this family; posterior border of carapace deeply arched; abdomen rounded, raised along the centre, epimera rounded and deeply grooved within the margin, surface finely granulated; segments decreasing in breadth from the second to the fifth (sixth and seventh segments wanting). Portions of the external maxillipeds only preserved; the three first joints of nearly all the five pairs of ambulatory limbs (coxopodites) have been preserved; near the base of the third pair may be seen the apertures of the efferent ducts of the ovaries; sternum somewhat deeply corrugated transversely, and relieved by five pairs of rather prominent tubercles, corresponding to the five thoracic somites which bear the five pairs of coxopodites or walking feet, from the bases of which latter they take their rise; the first pair of tubercles are very minute, and closely approximate to each other on the median line, each succeeding pair of tubercles increases in size and in distance apart just as the sternum increases in width from its anterior to its posterior border; they present the appearance of a double row of *mammæ*. The feet decrease in size from before backwards and are somewhat flattened in section, as in the recent *Scyllaridæ*.

Dimensions:—Length of carapace along the median line, 10 lines; length along the branchial and hepatic region, 1 inch; breadth at widest part, 10 lines; breadth of anterior border of carapace, 6 lines; breadth of posterior border, 8 lines; thickness from sternum to dorsal ridge, 7 lines.

Scyllaridia Bellii is readily distinguished from *S. Koenigii*, not only by its size, its more strongly-marked carapace,—rising to a very elevated ridge along the centre (see Fig. 2),—its more expanded branchial region and deeply-curved posterior border; but also in the relative openness of the orbital fossa in the former (in this respect offering an approach to *Thenus*, a genus allied to *Scyllarus*) as compared with the more perfectly inclosed orbit in the latter. Nor do I see any reason to doubt that the specimen here described is an adult individual. So far as its remains have been preserved to us, *Scyllaridia Bellii* is one of the most beautiful macrouran crustaceans found fossil. and when examined with a pocket-lens its minute details of structure are seen to be remarkably well preserved. It was obtained from the London-clay of Sheppy, and is now in the British Museum Collection.

I am indebted to my friend James Carter, Esq., of Cambridge, for sending me, some seven years since, a drawing of the caudal segments of a Crustacean, preserved in the Woodwardian Museum, which was believed to be, and was published at the time (with a note of interrogation), as referable to the genus *Squilla*.[1]

This specimen was obtained from the chloritic marl (Lower Chalk) near Cambridge. About the same period, my late lamented brother, Dr. S. P. Woodward, F.G.S., when on a visit to Mrs. Smith, of Tunbridge Wells (shortly before the death of that venerable lady, and most excellent naturalist), obtained for me further evidence of this same Crustacean, in Mrs. Smith's museum,[2] from the Grey Chalk of Dover. Since that time, by the kind interest of W. Whitaker, Esq., F.G.S., of H.M. Geological Survey of England and Wales, I have obtained the loan of two other specimens of this fossil from the Hard Chalk-rock of Luton, in Bedfordshire, collected by J. Saunders, Esq., of that place.

Having since been kindly allowed by Professor Sedgwick to examine and compare the Cambridge example with those subsequently obtained, and also with the recent genus *Squilla*, I arrived at the conclusion that it was not among the Stomapods, but among the Isopods, that we must look for the allies of our Cretaceous fossil.

All the four fossil specimens exhibit, under a pocket-lens, the same peculiar pitted and wrinkled ornamentation which the artist has attempted to convey in Plate XXII., Figs. 3–6. This peculiar kind of ornamentation I found especially repeated in the *Ægidæ*, the species belonging to which family are amongst the largest known Isopods, and are distinguished by "having their antennæ fixed in front of the head, the basal joint of the anterior pair being very broad and flat, and uniting together to form a margin in front of the head, not being concealed beneath the advanced cephalon; the outer foot-jaws have the basal joints moderately dilated, with three or four terminal joints, which are rarely palpiform; the *pereiopoda* (*thoracic* feet) are of moderate length, the anterior pair being generally the strongest, and fitted for prehension, being terminated by a robust curved finger, acute at the tip; whilst the hind-legs are gradually elongated and fitted for walking. The five segments of the *pleon* (*abdomen*) are very short, each on its underside supporting a pair of double foliaceous plates for respiration, whilst the last segment of the *pleon* (*telson*?) is large and flat, and bears on each side, near the base, a pair of flat appendages, scales arising from a basal joint, of which the inner angle is sometimes produced into a long style."[3]

I have figured an example of this family, the *Æga monophthalma*, Johnston (Pl. XXII., Fig. 7), for comparison with the fossil remains.

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[1] See Salter and Woodward's Chart of the Genera of Fossil Crustacea, section Stomapoda, etc., fig. 19. Engraved by J. W. Lowry, and now sold by J. Stanford.

[2] The specimen was presented at the time by Mrs. Smith, of Tunbridge Wells, to the British Museum.

[3] C. Spence Bate and J. O. Westwood, Hist. Brit. Sessile-eyed Crustacea, Part 17, June, 1867, p. 276. 8vo. Van Voorst.

In examining a large number of genera of recent Isopoda in the British Museum Collection, I noticed that the presence of a median ridge or keel to the telson or terminal joint was of rare occurrence in any species, the one figured in our plate being almost the only example met with. This character, combined with the finely dentated border of the telson, and the characteristic, punctate, and wrinkled ornamentation of the surface of the segments, led me to the conclusion that the genus *Æga*, offered the nearest living analogue to this fossil crustacean; and I therefore propose to name it *Palæga*, adding the specific name of *Carteri*, in honour of my friend James Carter, Esq., through whom I first became acquainted with this interesting fossil.

Description.—(Head and four anterior segments wanting.) Fifth, sixth, and seventh, thoracic, and five abdominal segments and telson present in Figs. 3, 4, and 6 (Fig. 5 uncertain, the telson being absent). Greatest breadth of body nearly equal to the length of eight segments, the relative proportion of length to breadth being about the same as in the living genus *Æga*. The abdominal segments preceding the telson are, however, slightly longer in proportion, in the fossil than in the recent form.

A line divides the thoracic segments transversely into two parts, the anterior being smooth and devoid of ornament, so as to admit of the free movement of the preceding and overlapping segment upon it, the posterior part being finely punctate and wrinkled; where not crushed, as in Fig. 3, the remains indicate that the terga were strongly arched as in *Æga;* the epimeral pieces are pointed and curved backwards; the fifth abdominal segment (that immediately preceding the telson) has no epimera visible; the telson is semicircular in outline, somewhat broader than long, and has a slightly raised keel or ridge passing down its centre and terminating posteriorly in a small spine; the posterior margin is dentated; the lateral margin is ornamented along the border with a series of raised *plicæ.* None of the appendages are visible, save in Fig. 6, in which the pair of foliaceous plates attached to the terminal segment are clearly to be seen occupying the same position as in Fig. 7.

It is much to be hoped that further research may bring to light more perfect remains of this interesting group, of which we know so little in the fossil state, but which, from their abundance at the present day, were in all probability well represented in past times.

A form closely allied, if not identical with *Palæga Carteri*, occurs in the Miocene of Turin, and has been described by Sismonda under the recent genus *Sphæroma* as *S. Gastaldi.*[1]

A comparison of the two recent genera, *Sphæroma* and *Æga*, with the fossil species, confirms me in the conclusion that *Palæga*, as already pointed out, is more nearly allied to the latter than to any other living genus of Isopods.

In *Sphæroma* the epimeral pieces are less recurved; the margin of the telson is less circular, and it is destitute of the median ridge or keel seen both in the recent *Æga monophthalma* (Plate XXII., Fig. 7), and the fossil *Palæga Cateri* (Plate XXII., Figs. 3–6). We prefer therefore to introduce the generic name *Palæga*, by which to distinguish the fossil forms, than to adopt the very objectionable alternative of referring to a recent genus, a doubtful and but partially known fossil.

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[1] Sismonda, Eug. Descrizione dei Pesci e Crostacei fossili nel Piemonte Taf. iii. fig. 10, in Mem. Accad. Torino, 2 Ser. Tom. 10. 1849.

Should Mr. Billings's discovery of the existence of legs in *Asaphus platycephalus* be found capable of general application to the *Trilobitæ*, we have in this group the earliest representatives of the *Isopoda*. Whilst admitting the desirability of the union of *Trilobita* and *Isopoda*, it should, however, be borne in mind that between these two groups important structural differences exist that cannot be lightly passed over: such, for instance, as the facial suture, the position of the eyes, and the trilobed character of the body-segments.

EXPLANATION OF PLATE XXII.

Fig. 1. *Scyllaridia Bellii*, sp. nov. dorsal aspect natural size (Coll. Mus. Brit.), London Clay, Sheppy.
2. *Scyllaridia Bellii*, side view of same, nat. size.
1a. „ „ dorsal aspect (enlarged) *o*, *o*, the eyes.
1b. „ „ ventral aspect (enlarged), *m*. position of maxillipeds, *e*. position of efferent orifice.
3. *Palæga Carteri*, sp. nov. Grey Chalk, Dover, nat. size (Coll. Mus. Brit.).
4. „ „ Chloritic Chalk, near Cambridge (Woodwardian Mus. Cam.)
5, 6. „ „ Chalk Rock, Luton, Beds. (Coll. J. Saunders, Esq., Luton).
7. *Æga monophthalma*, Johnston, N. British Coast, attached to Codfish (nat. size).

[In Fig. 3, the keel of the telson is not well seen, the surface of the tail segment being a good deal abraded, but the margin shows the mucro and the characteristic dentated border observable in the Cambridge specimen, Fig. 4.]

(To be continued.)

II.—Notes upon the Occurrence of the Post-Pliocene Drift of Charnwood Forest.

By W. C. Lucy, F.G.S., Gloucester.

During the investigations I made on the "Post-Pliocene Gravels of the Severn, Avon, and Evenlode, and their extension over the Cotteswold Hills," the result of which I embodied in a paper read before the members of the Cotteswold Club in the early part of 1869, and is now published in their "Proceedings," many of the boulders found by me, on examination by R. Etheridge, Esq., of Jermyn Street, were determined to be syenite and granite from Charnwood.

Being naturally anxious to see the rocks *in situ*, from which they were derived, I recently made an excursion to the Forest, taking up my quarters at a central position, the picturesque village of Woodhouse Eaves.

My first walk was to Mount Sorrel, and on my way I was much surprised to see a good deal of flint and drift, having heard that there was no distinct evidence that that part of the country had been submerged since the deposition of the New Red. After visiting the quarries, under the able guidance of the manager, Mr. Hamblyn, ascended the hill by the road on the N.E. side, and, on reaching a small plateau, at an elevation of 110 feet above the river Soar, my attention was attracted, in a hole recently made, to some small pieces of white stone, apparently resembling chalk, which, on examination, I found to be chalk. This unexpected discovery induced me to notice very closely the place where they came from, and I found a surface soil, varying from one to two feet, in which were some New Red pebbles, and angular pieces of the Sorrel rock; underneath was some tenacious clay, like Boulder-clay, three to twelve inches in thickness, and resting on New Red Marl, with a good deal of small chalk embedded in it; some pieces were, however, larger than a hen's egg, very hard, and showing evident marks of Glacial striation; there were also several angular flints, one bit of Oolite, evidently derived from the Coral Rag of Yorkshire, and two small Lower Lias Gryphites, the *G. incurva.*

As the Barrow beds, to which the Gryphæa belong, were in the plain about a mile to the N.E., their occurrence in such a position suggested to my mind how great a change the country must have undergone within comparatively recent Geological time.

A few days afterwards, I again visited the hill, and on this occasion was accompanied by Mr. Hamblyn. We found more chalk and angular flints, and traced small pieces of the latter to the summit of the hill, which is at an increased elevation of 80 feet. As the Soar below is about 200 feet above the sea-level, the highest point of Mount Sorrel is nearly 400 feet high. We saw also some fine gravel, formed of the disintegrated rock of the hill.

The flints I afterwards traced to the Beacon Hill, Bawdon Castle, and in a field just after leaving Copt Oak, on the left hand side of the new private carriage road, made by W. P. Herrick, Esq., to his property at Bardon Hill, where draining had lately been done, they were in abundance. Throughout the whole forest I found they were rarely absent.

The Northern Drift, called by the inhabitants "Boulders," is, in places, largely scattered over the surface of the ground. I found them extending far up the N.W. side of Bardon Hill, and I am disposed to think they attain rather a higher elevation than the flints.

There is a great quantity of local drift, derived from every rock of which the hills are composed, and some of very large size, many boulders weighing from one cwt. to at least a ton; and near to Charley I met with a large block of granite well striated.

The great interest of the Charnwood Forest seems hitherto to have been mainly confined to the age, nature, and composition of the rocks; but I venture to suggest that, to the Physical Geologist, there is much to engage the attention in the evident remains of an extensive denudation and meteoric abrasion in the numerous valleys which intersect Charnwood.

With the object of tracing the gravel into the plain, I drove from Woodhouse Eaves to Leicester, and, on my way, found it, as I expected, on the high flat ground of Thurcaston, which extends to

Birstall Lodge, and also after descending the very steep hill from near the latter place, and on to Belgrave, near the river. There are, therefore, the beds of gravel just above the river, where the Mammalian remains were found, which are now in the Leicester Museum; the high flat ground of Thurcaston, and an extension of drift of an older date occurring on the flanks of the hills of Charnwood.

The great quantity of drift in Leicestershire was, many years ago, noticed in the *Reliquiæ Diluvianæ*, by Dr. Buckland, in which he gives the following extract from the Rev. W. D. Conybeare: "From Houghton-on-the-Hill, near Leicester, to Braunston, near Daventry, proceeding by Market Harborough and Lutterworth, the traveller passes over a continuous bed of gravel for about forty miles. Near Hinckley, great depositions of gravel, probably connected with this mass, are found, and afford pebbles, containing specimens of the organic remains of most of the Secondary strata in England. This deposition may probably be traced continuously to that of Shipston-on-Stour, most of the hillocks scattered over the Lias and Red Marl tract between Southam and Shipston being covered with this gravel." And again he says, "It would, however, not be difficult in many places, as, for instance, on the West of Market Harborough, and in the valley of Shipston-on-Stour, to form almost a complete geological series of English rocks from among these rounded fragments, which often occur in boulders of very considerable size."

This therefore shows a clear connexion between the gravels of Leicestershire and those near to Shipston-on-Stour, which latter I have studied with some attention, and have clearly traced them on to the high ground of the Cotteswold Hills, and I am firmly impressed with the opinion that Charnwood Forest was submerged at the same time as the Cotteswolds.

I hope, shortly, to work out the Leicestershire Gravels, and to illustrate them in like manner to my Memoir on the Cotteswold Drifts.

III.—ON THE COAL-BEARING ROCKS OF SOUTHERN CHILE.

By G. A. LEBOUR, F.G.S., F.R.G.S.,
of the Geological Survey of England and Wales;
and WM. MUNDLE, M.E., member of the North of England Inst. of Min. Engin.

LITTLE as the Geology of South America has been worked, yet the presence of coal along the coast of Chile has long been known to navigators and others. Of late years this coal has been worked in sundry places—in short, wherever the circumstances seemed most favourable. The strata in which the seams occur, were made the subject of considerable study from a palæontological point of view by D'Orbigny and by Darwin; but not until the last ten or fifteen years have the resources of the country, with regard to this branch of industry, been examined into sufficiently to enable a correct estimate to be made of them. The surveys, which have been the direct result of the interest awakened by the knowledge of the presence of *workable seams* of lignite in Chile, have been greatly conducive to a more perfect knowledge of the geological structure of the coast; and the consequent accumulation of material for its study has, we believe, brought it within our power, not only to add to the very limited stock of notes on the subject, but also, it is hoped, to give such explanations of some of the more obscure facts connected therewith as were, from the want of reliable data, either overlooked by earlier observers, or only vaguely suggested by them.

We may premise our remarks by saying that although the majority of the facts alluded to in this paper will be found to hold good for the whole of the Tertiary formation under consideration, they apply more strictly to the area comprised between Concepcion and Valdivia, where these rocks have been very carefully examined during a lengthened professional stay by Mr. Mundle. This portion of the coast which we have selected to illustrate the general points of our subject, contains the two most important and largest collieries of the country, namely those of Coronel and Lota, from the workings connected with which a large amount of the information in these pages has been obtained.

The Tertiary rocks (as, for want of a better term, we shall for the present call them) form a narrow strip of beds following the coast-line of Chile, and the general inclination of which is a very gentle one to the W. or N.W., that is, towards the sea. These beds rest unconformably on the older metamorphic and volcanic rocks of the country (see fig. 1), which form the bulk of the lesser chain of mountains bordering the coast, the long interior undulating plain and the great easternmost Cordillera. This is shown in fig. 1, which is a sketch section on a true scale, running from a point just S. of the mouth of the Lebu river, crossing the valley of the Bio-Bio, near Santa Fé, passing a little to the S. of Los Angeles, entering the region of the Andes proper, near Lake Canquen, and ending a few miles E. of the active volcano of Antuco.

This section is merely given to show the relative position of the larger groups of rocks, and lays claim to nothing beyond general accuracy. In order that it may the better fulfil our object, however, we have made it cut the coast at a point very near to both Coronel and Lota, to which, as we have stated above, our observations will mainly apply. At a number of other places along the coast of Chile and Patagonia, these coal-bearing rocks have been observed, from a place called Talcahuano, a few miles north of Concepcion (where the coal, says Mr. Bollaert, who surveyed the neighbourhood in 1828, "was so inferior as to be thrown aside"), [1] to some of the islands of the Chonos Archipelago, according to Darwin,[2] or even as far south as the Straits of Magellan, where coal similar in general character to that under consideration, was observed during a very hasty visit by Mr. Mundle in 1865.[3]

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[1] "Observations on the Coal formation in Chile," by W. Bollaert, Esq., F.R.G.S., Journal of the R.G.S., vol. xxv., p. 172.

[2] Geological Observations on South America, by C. Darwin. London, 1846.

[3] Mr. W. Bollaert, in the paper referred to above, also mentions coal as having been found at the Straits of Magellan.

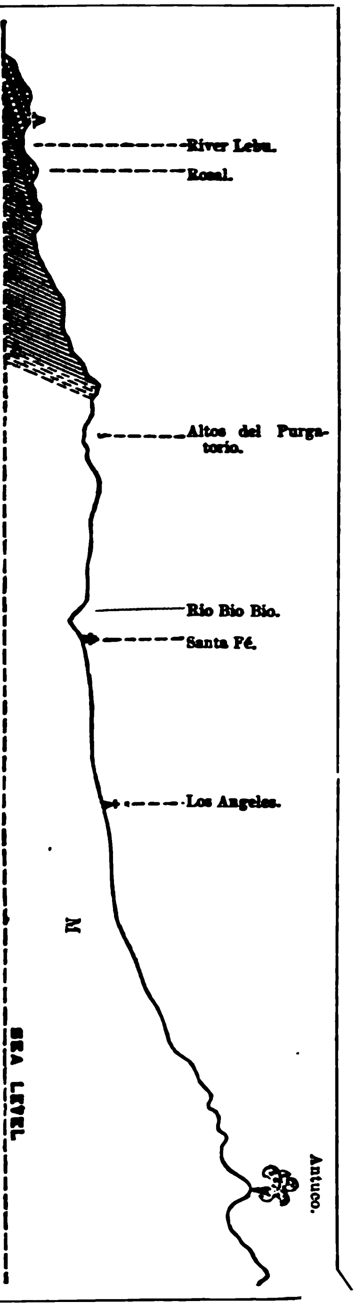

Fig. 1. Section from Pacific Ocean to Andes. A. Tertiary Coal-bearing Formation. M. Mica-schists and other Metamorphic Rocks with intrusive rocks.

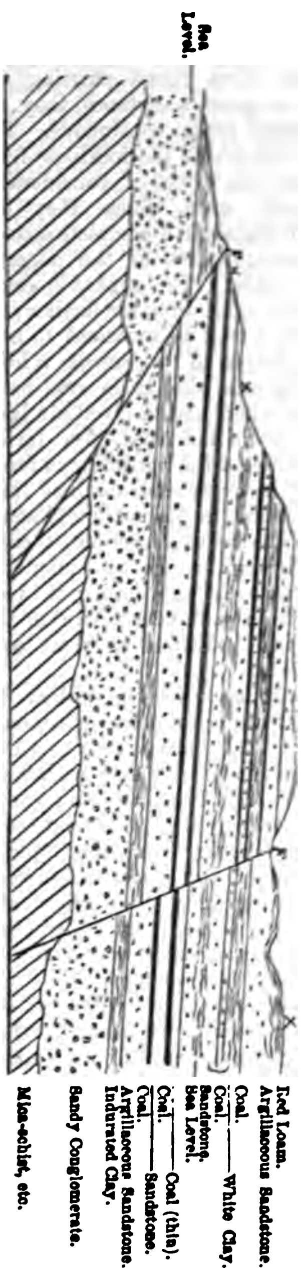

Fig. 2. Section at Coronel. Chile.

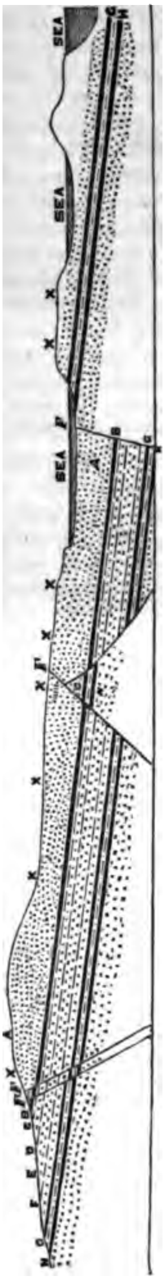

FIG. 3.—Section at the Lota Coal Mines, Chile, from Outcrop of Coal-bearing Beds to the Sea. A, Sandstone.—B, Top Seam.—C, Shale and Sandstone.—D, Coal with stone.—E, Sandstone.—F, Coal with stone.—G, Second Seam.—H, Third Seam.—F, Faults.—× denotes the position of a Pit or Bore-hole.

Scale: 240 yards to an inch.

But although beds agreeing in character, composition, and organic remains, and almost invariably lignitiferous, are thus found skirting the coast for so great a distance, they are by no means really continuous. The breaks which divide the localities from each other are often of considerable length, and, even where they are shortest, bring about a complete change in the arrangements of the deposits on either side. The probable cause of this we shall hint at farther on. At present it will be sufficient to note that the ridges of micaceous schists which separate the little coal-fields from each other, and the contour lines of which were the coast-lines during the deposition of the lignitiferous formation, are in every case distinct lines of demarcation, to the north and south of which the vertical sections, though cutting through rocks of undoubted contemporaneous age, are yet very different from each other, both in the position and thickness of their constituent beds.

This will at once be evident by glancing at the accompanying sections, the first of which is taken from a line of pits sunk in the Coronel workings, and is separated from the other (measured at Lota) by a ridge of micaceous schists, advancing from the interior into the sea; the distance between the two being only five miles, and the strata cut through by both being. without doubt, equivalent as far as geological age is concerned.

The coal-seams, it will be observed, are even less constant than the other members of the above sections.

Keeping then this arrangement of the beds in mind, we cannot be unprepared for the great dissimilarity which we find existing in the various accounts, both official and unofficial, of the capabilities of the

Chile coal-fields viewed from a commercial point of view. These vary according to the localities from which the materials of the reports have been obtained, and are very likely correct in each particular instance.

Although the object of the present paper is to describe the newer formations of Southern Chile from a purely geological, and not from an industrial point of view, yet it may be as well to give, once for all, our opinion as to the value of the coal hitherto known and worked, or which may possibly be found there. The coals won at Puchoco, Coronel, and Lota, just south of Concepcion, are universally acknowledged to be the best in the district. At Valdivia, considerably further south, the coal is also well developed, but is not so well situated for being extensively worked. Probably, still further south along the coast of Patagonia, coal may some day be profitably worked,[1] but there the amount of vegetation (to which Darwin hints the presence of lignites may be due) will long stand in the way of accurate geological surveys.

At the other places where coal has been won, it has proved little more than an inferior lignite, and even the better seams which we have named above, and a detailed account of some of which will be found in the measured section given below, can scarcely be much commended when compared even with our inferior European coals. Besides which it may be mentioned that the workable seams of Coronel and Lota are nearly worked out by this time, and will therefore be not much longer of any importance at all. In the appendix we quote from Mr. Bollaert's valuable paper, above referred to, analyses of the coals from these localities. Leaving this portion of our subject thus lightly touched upon, it will, perhaps, be best to give now a full description of the stratigraphical arrangement of the coal-bearing deposits at some particular point, which may serve as a key to the mode of occurrence of the strata, in that district at least which has been best studied. For this purpose we have chosen a section at Coronel, the perfect accuracy of which we can vouch for throughout, it having been measured bed by bed under the superintendence of Mr. Mundle. The uppermost few feet of the country consist, for the most part, of a red earthy loam, called locally Tierra Colorada, which is due to the decomposition of the volcanic rocks forming the higher parts of the interior. Below this red earth, which often attains a considerable thickness, we come to the sub-soil proper, which we will take as being the highest known member of the series. This consists, at Coronel, of—

	Ft.	In.
1. A grey argillaceous sandstone, fine-grained and micaceous . . .	45	11
2. Below this is a band of grey calcareous sandstone, also micaceous, but with small veins of Calc-spar	7	0
3. We next come to a sandstone similar to No. 1, but containing fossils (marine shells). This bed is very constant, and is, it is thought by the miners, identical with a similar one at Lota	21	6

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[1] *Vide* "Informe sobre las minas de carbon del sur de Chile," by Luis Larroque, in the "Anales de la Universidad de Chile." Santiago, 1865.

		Ft.	In.
4.	Next is another band of Calcareous sandstone, very fine-grained and hard	6	0
5.	A light bluish-grey argillaceous sandstone	6	0
6.	*Coal*, hard and good, but containing Iron pyrites, and in some parts small nodules. These nodules contain many plant-remains (monocotyledons), and some reptilian-remains. This is the highest coal-seam in the district	2	6
7.	A thin band of dark-brown bituminous clay, greasy to the touch, and full of vegetable débris, filling the place of a true under-clay	0	6
8.	A soft whitish clay, which passes gradually in its lower part into a fine-grained grey argillaceous sandstone, resembling the upper beds already mentioned, but containing a small quantity of lime.	26	0
9.	We now come to the *Second Coal*. This seam is good and clean, but soft, and leaves much ash in burning	2	0
10.	A light-grey argillaceous sandstone	5	6
11.	The *Third Coal*-seam, six inches of which are taken by a band of brown micaceous shale, which divides it in the middle	2	11
12.	A fine grey arenaceous shale, in the upper part compact and hard, with a great quantity of vegetable remains, which give a streaked appearance to the rock; and at the base, a dark-brownish, indurated clay, speckled with black round spots, the centre of each of which is formed by a carbonized stem	8	0
13.	A thin band of black bituminous shale, scared with shining *Coal*. This is combustible, and after burning, is perfectly white, but it is unavailable for practical purposes	0	9
14.	A brownish indurated clay, similar to No. 12, but without spots and stems	3	7
15.	A whitish argillaceous sandstone, containing, in the upper part, many remains of ferns and trunks of trees. A thin band of shale intersects this bed, in which are numerous veins of Hæmatite and Carbonate of Lime. The sandstone gets coarser in its lower part	20	0
16.	A dark-grey shale, with carbonized remains of plants	15	10
17.	A brownish clay, micaceous, and containing in parts concretionary nodules of a pure green clay	5	3
18.	A hard grey shale, rough to the touch, with black spots in parts, and with a conchoidal fracture	4	0
19.	A white crystalline sandstone, containing (as indeed most of the grits enumerated in this section do) disseminated grains of Hornblende	5	5
20.	Alternating beds of argillaceous and calcareous sandstones, the latter being the thinner, and the former containing vegetable remains, especially in the upper parts	20	0
21.	A band of black bituminous shale	2	0
22.	The *Fourth Coal*-seam; an unimportant one, very friable, and with partings of white Dolomite and Gypsum.	0	7
23.	Black bituminous shales (in which vegetable remains become rarer towards the base), passing into a light-grey indurated clay, with carbonized plants, forming confused masses, which, with several included bands, (in most of which are impressions of leaves, etc.,) is distinctly divisible into nine different beds	14	0
24.	The *Fifth Coal*, good, hard, and clean, with pyrites in places. This is a workable seam. The floor of this coal is formed of a dark-brown bituminous slate clay, in all respects similar to the Under-clay of the First Seam (No. 6), and only a few inches thick	3	3
25.	A brownish-grey shale, very micaceous, with some impressions of leaves, and with Dolomite partings	6	6
26.	A fine-grained hard calcareous grit	0	5
27.	A spotted arenaceous shale, with scares of coal	6	4
28.	The *Sixth Coal*, divided into two seams, by one foot seven inches of grey bituminous shale, with remains of plants. The upper bed of coal is of good quality, but the lower one is earthy and bad	2	5
29.	The Under-clay to this seam is a black bituminous shale, scared with coal	1	4
30.	A blackish-grey Sandstone, streaked with whitish lines	3	9
31.	The *Seventh Coal*, good, and very clean	0	7
32.	A black bituminous shale	1	4
33.	The *Eighth Coal*-seam. This is the most important of the district, and consists of a very good, hard, and clean coal. This is, of course, the chiefly-worked seam	4	9
34.	Its Under-clay is a dark-brown bituminous shale	1	4
35.	A grey indurated clay, in parts compact and hard, in others soft and plastic	4	0
36.	A grey arenaceous shale, well stratified, very fine grained, with the grains		

		Ft.	In.
	of Quartz often replaced by grains of Hornblende, and inclosing here and there crystals of Calc-spar and small particles of crystallized Iron-pyrites	1	0
37.	A bluish-grey calcareous Sandstone, very hard and fine-grained, and much jointed, containing crystalline Dolomite in the partings . .	1	0
38.	A strong grey argillaceous sandstone, slightly micaceous, coarse, with disseminated crystals of Hornblende and Chlorite	75	0
39.	A brownish shale mixed with coarse particles of sand	1	3
40.	The *Ninth* and last *Coal*-seam, of fair quality	0	2
41.	Greyish and bluish shales, scared in some places by red Oxide of Iron .	25	0
42.	A greenish-grey argillaceous sandstone, micaceous and fine-grained, containing many fragments of trunks of trees and ferns	2	10
43.	A light bluish-grey arenaceous shale, with seares of coal	6	6
44.	Is a rock distinctly different from any of those we have passed through in this section; this is a brownish-red argillaceous conglomerate, coarse-grained, with various sized pebbles of White Quartz, Granite, Syenite, Greenstone, Porphyry, Quartzite, etc.	3	0
45.	A much stronger thick conglomerate, more compact than the last, but with smaller sized pebbles, and consisting, in addition, of a large proportion of micaceous and Chloritic rocks	210	0
	Total . . .	587	0

This last stratum is in direct contact with the metamorphic rocks which form the mountain range, and the dividing ridges of the Coal-district, and lies unconformably upon them. It does not enter within the scope of this paper to treat more largely of these older mica schists, chloritic schists, talcose slates, clay slates, etc. The section we have given above will, perhaps, suffice to give one a correct idea of the structural characteristics of the formation under consideration, (see Fig. 2). The next point we shall advert to, is one of more theoretical interest; namely, the mode of deposition of these beds. That they are in a great and preponderating measure of purely marine, and in the minority of cases, at least, of estuarine origin, may, we think, be safely inferred from the fossils which they contain, and that these conditions very rapidly interchanged is, likewise, easily to be seen by the thinness and variety of the beds in our section. The great and varying instability of the land during the formation of these beds, which was the evident cause of this, is little indeed to be wondered at, when we consider that a great portion of that vast upheaval to which we owe the Andes was actually going on at this very period, whether we take it to be a late Secondary one, as has been suggested, we believe, by D'Orbigny and E. Forbes, or whether, as Darwin thinks, it be one "verging on the commencement of the Tertiary era."

This alternation of the circumstances under which the deposition took place leads us, with the help of a few collateral considerations, to what we believe to be a true explanation of the dissimilarity, before referred to, between the sets of beds on either side of the ridges of older rock breaking their continuity. We are not aware that this striking discrepancy between these neighbouring sections has ever been explained, or even noticed, by any former observer. Darwin remarks, that these formations have, in some cases, "apparently been accumulated in troughs, formed by submarine ridges," in others, that "the Tertiary strata seem to have been separately accumulated in bays, now forming the mouths of valleys," but nothing further. In order to understand our argument rightly, it will be necessary to examine briefly the conditions under which the depositions of the present day take place in the selfsame regions; and as we have already taken the two localities of Coronel and Lota as types of the more ancient sedimentary accumulations, so shall we make use of them again in this instance, as typical of those at present forming. The accompanying sketch map will, it is hoped, render our meaning clearer.

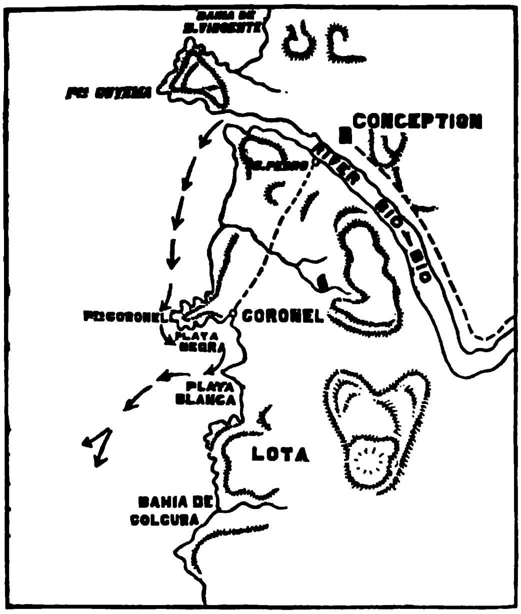

Fig. 4.—Sketch of part of the Chilian Coast.

The mouth of the Bio-Bio is, it will be seen, to the north of both Coronel and Lota. The currents along the coast have a southerly direction, and are of considerable strength. Now, the sediment held in suspension by the Bio-Bio (of which it carries vast quantities into the sea) is of a dark, almost black, colour, consisting in fact of sand derived from the black volcanic rocks through which it flows, and which are being continually worn down and transported by it, and by the many tributaries to which it owes its size. This black sand shall serve as an indicator. For observe that the shores of the two bays immediately south of the Punta Coronel have different names applied to them, viz., the northern one, that nearest the mouth of the Bio-Bio, is called Playa-negra, and the southern one Playa-blanca: that is, the black beach and the white beach. These two bays are separated by a narrow ridge of rock—mica-schist—running into the sea. The black beach receives the black sediment of the Bio-Bio, brought to it by the current which exerts its power on that river and its freight, from the moment it reaches the sea. The arrows on the map show the direction of the current. After blackening the Playa-negra, this current, which may be called the oceanic prolongation of the Bio-Bio, is diverted from its southward course by the ridge of metamorphic rock, and is driven out to sea, where it spends what is left of its cargo of black sand; and thus does it come to pass that the Playa-blanca is white, and not in any degree tainted by the *black* river. Here then we have two contiguous and contemporaneous deposits being formed of totally different materials, and ontaining different organic remains. The one, the black beach, made up of the débris of volcanic rocks, and containing estuarine, nd possibly even fluviatile, animals and plants; and the other, a white sandy beach, composed of the débris of Tertiary sandstones, nd having a purely marine littoral fauna. This, we believe, which re see at work now, was at work then, and we thus have the true ey to the meaning of the want of resemblance which exists between he numerous coal-fields of the same age, which are situated all long the coast of Western South America. And, to render the nalogy between the recent case and the ancient one more striking, re may remark, that the spur of rock which separates and causes he dissimilarity of the two beach-deposits is the very same one which divides the coal-field of Coronel from that of Lota. Seldom an one see so completely the little change which Time brings about n the manner in which Nature works. With regard to the geological ge[1] of the Coal-bearing formation, we have little to say beyond his, that the belief of Darwin, that these beds belong either to a ery old Tertiary epoch, or possibly to an era intermediate between he Secondary and the Tertiary, seems to us to be as near the truth as t is possible to arrive at, with the scanty lists of fossils at our disosal. Among these we find none that have not been enumerated efore, either by Darwin or by D'Orbigny; therefore we shall limit he palæontological portion of this paper to quoting the list given by Darwin (see Appendix).

A comparison between these Coal-fields and other well-known ertiary ones might seem, at first sight, appropriate; but the peculiarities, both of age and manner, of deposition appertaining to the eds in question, preclude the possibility of their being brought nto the same category as either the German *Braun-kohl* formations, he Bovey-Tracey lacustrine deposits, or even as the Brazilian coalearing rocks of the river Jaguarão, which, according to Professor gassiz, belong to the true Carboniferous period.[2]

Before concluding this paper, it is necessary to say a few words especting the faults which dislocate the district we have been xamining. Of course we are as yet only enabled to speak of those which have been observed, and proved in the carrying on of mining perations, the principal of which will be seen marked in the horiontal sections which illustrate our remarks (see Figs. 2, 3, and 5).

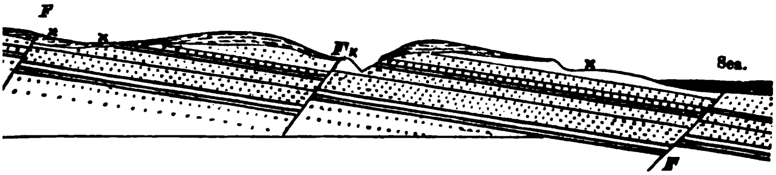

Fig. 5.—Section of Coal-bearing Beds at Lota, Chile.

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[1] This I hope to consider more fully in another paper.—G.A.L.

[2] "Reports respecting Coal," Blue Book, London, 1867, p. 23. With Professor gassiz's decision I am however disposed, with all deference, to differ.—G. A. L.

These faults run, in the great majority of cases, in a more or less N. and S. direction, that is, approximately parallel to the sea-shore, and, which is more significant, parallel also to the mountain-chains of the country. It need scarcely be pointed out that this parallelism between the lines of dislocation and the axes of elevation, is of the highest theoretical value, as showing, beyond doubt, that the elevatory action, to which the great Andian Cordillera is due, has been at work *since*, probably long since, the close of the era during which the deposition of the Chilian Coal-fields took place. This is only a confirmation of the acknowledged fact, that a very great portion of the elevation of the Andes (5,000 or 6,000 feet at least, according to Dana) was gained in Tertiary times.

From a mining and practical point of view, these faults are of value, insomuch as, by their constant upthrows of the coal-seams seawards, a considerable amount of workable coal is saved, which otherwise would be quite lost and useless. And here we may, perhaps, advert to a consequence of a want of knowledge of such faults: in Mr. W. Bollaert's paper, to which we have so often referred, the author mentions that the coal-workings at Coronel were likely to become much more extensive than those at Lota, whereas exactly the reverse has come to pass, the Lota seams being capable of being worked far under the sea, while those of Coronel have been been completely cut off by it (see Fig. 5).

With these somewhat crude remarks we conclude this paper. The analyses of coals and lists of fossils are given in the Appendix.

APPENDIX.

(*a.*) List of fossils from the coast between the Chonos Archipelago to Concepcion, form Darwin's "Geology of South America."

Turritella suturalis, G. B. Sby.
T. Chilensis, G. B. Sby.
Sigaretus subglobosus, G. B. Sby.
Cytherea (?) *sulculosa* (?), G. B. Sby.
Voluta, fragments of.
Bulla cosmophila, G. B. Sby.
Pleurotoma subæqualis, G. B. Sby.
P. araucana, D'Orbig.
Fusus cleryanus, D'Orbig.
F. subreflexus (?).
F. difficilis, D'Orbig.
Triton leucostomoides, G. B. Sby.
Venus auca, D'Orbig.
Venus, fragments of.
Tellinides (?) *oblonga*, G. B. Sby.
Natica striolata, G. B. Sby.
N. (?) *pumila*, G. B. Sby.
N. araucana, D'Orbig.
N. Australis, D'Orbig.
Scalaria Chilensis, D'Orbig.
Pyrula longirostra, D'Orbig.
Cardium auca, D'Orbig.
C. acuticostatum, D'Orbig.
Mactra cicileana, D'Orbig.
M. araucana, D'Orbig.
Area araucana, D'Orbig.
Nucula Largillierti, D'Orbig.
Dentalium majus, G. B. Sby.
Trigonia Hanetiana, D'Orbig.
Pecten, fragments of two species?
Baculites vagina, E. Forbes.
Nautilus D'Orbignyanus, E. Forbes.
Ammonites, fragments of one specimen.

It is on the last-named fossils more especially that the Cretaceous age of the lignitiferous beds was contended for by D'Orbigny.

(*b.*) The following analyses of coals are taken from Mr. W. Bollaert's paper in the Journal of the Geographical Society, vol. xxv.. p. 175.

Analyses of the lignite of Talcahuano, by Admiralty Investigation Committee:

Ash	6·92
Carbon	70·71
Hydrogen	6·44
Oxygen, Sulphur, Nitrogen	15·93
	100·00

Of Lota coal, by Dr. Playfair:

Ash	5·68
Carbon	78·30
Hydrogen	5·30
Oxygen	8·37
Sulphur	1·06
Nitrogen	1·09
	100·00

Of Lota first seam, by Mr. Abel, of Coquimbo:

Ash	2·05
Carbon	83·70
Hydrogen	1·02
Oxygen and Nitrogen	13·23
	100·00

IV.—ON THE GLACIAL AND POST-GLACIAL DEPOSITS IN THE NEIGHBOURHOOD OF LLANDUDNO.[1]

By HUGH F. HALL, F.G.S.

I HAVE been led to think that a description of the drift-beds in the neighbourhood of Llandudno might be interesting to the Section, on account of the discussion which took place on Mr. Morton's paper, as to the description of pebbles contained in the "Boulder-clay."

The section I have drawn is a general section, taken from a careful examination of the beds exposed at the following places: Gogarth, West side of the Little Orme, East side Little Orme, Dyganwy, Rhos, Colwyn, and Llandulas.

The base-bed taken is the Mountain Limestone. At the Little Orme is exposed above this a bed of three to five feet in thickness of Mountain-limestone rubble, angular fragments, which may probably be accounted for by the action of frost during the earlier part of the Glacial period, breaking up the exposed rock into fragments, which in this sheltered corner have not been carried away by the ice-sheet which has produced the overlying Boulder-clay, and in its greatest exposure is about 150 feet in thickness. This bed I regard as the result of the grinding down of the subjacent strata by land-ice, which, at this period, must have covered the land down probably to the water's edge; in fact, the *true Glacial period*. The materials of which these beds are composed are invariably those which would result from the breaking up and grinding down of the rocks in the immediate neighbourhood. Thus, at Rhos, it is a very stiff, dark bluish-grey clay, very full of small pebbles, principally of slate, all ice-scratched, with many large blocks of Mountain-limestone, Greenstone, and Volcanic-grits, three, four, and five feet in diameter, in many cases still showing, though exposed to the action of the present sea, ice grooves and smoothing. The general character of this bed is much the same at the Little Orme, the new features being boulders of Old Red Sandstone, Schist, and Cambrian conglomerate. On the West side of the Little Orme this bed is distinguished by a large quantity of angular fragments of chert.

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[1] Read before Geological Section, British Association, Liverpool, 1870.

At Gogarth, the clay F, where exposed on the shore, and wetted by the tide, is very stiff, but in the cliff it is very hard and compact, more so than many sandstone rocks. It varies very much in its constituents, in some places being dark-brown, in others, grey in colour, but everywhere very gritty and sandy, and full of scratched pebbles, with many fragments of chert. Numerous boulders of greenstone, trap, slate, and Old Red Sandstone, with angular and subangular masses of Mountain-limestone, are contained in it. Slate pebbles are not common in this bed, as in those at the Little Orme, Rhos, and Colwyn,—angular chert fragments are probably the most characteristic. On the top of this bed at Gogarth lies a seam of great boulders of trap, greenstone, slate and Old Red Sandstone, with masses of Mountain-limestone, left, in all likelihood, when the denudation of its upper surface had washed away the surrounding clay without having the power to carry off the larger fragments.

At Dyganwy we find a low cliff, about 20 feet high, of black clay, which is evidently derived from the grinding down of the slate, which crops out in the farm-road of Maesdu. This is decidedly the best place to observe ice-markings, as the shore is covered to far below low-water mark with great masses of greenstone, volcanic-ash, conglomerates, and slate, all deeply striated and finely polished. These masses are in greatest quantity at the west end of the cliff, becoming fewer and smaller to the east end, where the clayey matrix changes from black to a dull brown, the result of a change from the slate to the lighter-coloured ash-beds, of which the hills of Bryngosol and Dyganwy, lying immediately behind, are composed. This Boulder-clay I believe at one time to have filled up all the valleys, and to have covered even the mountain-tops, as I found, at a height of at least 400 feet on the Great Orme, a greenstone boulder, which I believe to have been derived from this bed.

The clay rises in bosses along the shore, giving clear evidence of denudation, and consequent *unconformability* to the overlying beds. It is now entirely removed from the mountain-tops, and from many of the valleys, showing that it must have been exposed to a very considerable denudation at what I believe to have been the close of the Glacial period. It must then have been depressed below the sea-level for a considerable depth to have allowed the deposition of a bed (E^2) of 20 feet *stratified* grey clay, with ice-scratched pebbles sparsely distributed, which occupies one of the hollows in the denuded surface of the bed F at the Little Orme. This stratified clay is clearly a denudation bed, derived from the redistribution of the bed that I have just described as the true *Glacial Boulder-clay.* Where the layers of this (E^2) stratified clay have opened by weathering, they show very distinct ripple and rain marks.

The next overlying bed consists of a development of about 20 feet of irregular and false-bedded sands and gravels. I look upon it as of the same age as the stratified grey clay last mentioned, being the shore condition of the same period. A patch of about five feet of green-coloured sand was to be seen in the Little Orme section, lying above the red and yellow sands and gravels, and with thick beds of red clay, false-bedded both with it and the yellow sands below. It occasionally hardens into a thin bed of conglomerate, forming a marked division on the cliff-face. On the west side of the Little Orme the whole bed is cemented by carbonate of lime into a hard conglomerate, masses of which are to be seen on the shore 12 to 20 feet in diameter. The upper portion is composed of finer pebbles and sand, and forms a thin band of hard rock.

After the shore condition, evidenced by the last-named beds, had ceased, through the deepening of the water covering the old land surface, a deposit of—

Red clay (D), which is everywhere of one character, has been brought down by currents, bearing icebergs and icefloes, from the more northern regions of Ireland, Cumberland, and Scotland, which, probably from their higher lands, still sent down glaciers to the sea. The uniformity of this deposit, the paucity of pebbles compared with the bed F, the scarcity especially of scratched pebbles, and the fact that it contains marine shells, as does also the (E) gravel bed, all show that it has been formed under very different circumstances from the glacial bed F, and, as it appears to me, at a time when glacial conditions were modified by a warmer and more genial climate.

The relative position of land and water was again altered by the elevation of all the beds already considered, when the gravels and sands (C) were deposited.

These are best illustrated by the great ballast pit at Colwyn, the present existence of which is explainable by its occupying nearly the centre of a great valley of denudation in the Red Clay, and to the recess of the shore between the hills of Bryn Ewian and Colwyn Head, the current passing eastward from one point to the other, not having sufficient power to remove the pebbles, once rolled up in this quiet retreat by the breaking waves. The bed is exposed to a depth of fifty feet, but this is evidently short of the entire thickness.

The last bed to which I have to call your attention, is a small deposit of blue-black clay, without pebbles, which is exposed in the Dyganwy section. That the underlying bed F, was covered with the red clays (D), I think there can be no doubt; indeed, I conceive the red clay to have covered the whole district in one great sheet, from end to end. This must have been entirely denuded, and the black clay (F) exposed to a second denudation, which has resulted in the thin bed of re-distributed black clay now referred to. Such is the sequence of the beds.

I wish to call your attention to a few points:

1st. That *colour* is no criterion for deciding as to the Glacial bed F, which at Gogarth is dark-brown and grey; at Dyganwy, almost black; Little Orme, dark grey; Rhos, a lighter grey; Colwyn shore, blue; and Llandulas, red-brown; in fact, the colour depends upon the materials of which the rocks in the vicinity are composed.

2nd. That the materials, of which this clay is composed, are always those found in the immediate neighbourhood, and even the large Boulders can generally be traced to no great distance. Thus, the Gogarth clay is evidently the result of the grinding down of the mica schists and limestones of Anglesey, and probably of the Millstone grit, which is now entirely denuded from the district; the greenstone, trap, slate, and Old Red Sandstone Boulders found in it, being all traceable to Anglesey as their source. I may here remark, that this clay, on the opposite shore of Anglesey, shows the same composition as at the Orme, except that it contains numerous schist pebbles, which are wanting at the Orme, being probably ground down before reaching that point. The clay east and west of the Little Orme and at Rhos, shows the result of the passage of the ice over the Mountain limestone and Silurian beds, the latter supplying the adhesive material which makes the clay here so much stiffer. At Dyganwy the black clay is from the underlying slates, and the greenstone, slate, and volcanic rock boulders, are easily traceable to the hills between Conway and Bangor, the greater sparseness of the pebbles at the east end of the section being due to the main course of the ice being through the valley nearer the Great Orme, its current being retarded eastwards by the Bryngosol and Dyganwy hills, probably deflecting part of the ice-flow through the valley of the Conway, towards Abergonol and Colwyn. At Llandulas the reddish-brown is due to the wearing of the Old Red Sandstone, which is still found inland, and many large boulders of which are seen on the shore.

3rd. I conceive this clay to be the result of the pressure and passage of land-ice, disintegrating the whole surface of the country which it capped, and I would confine the term "*Boulder-clay*" to this one bed, believing it to be the only *true Glacial clay*.

4th. This clay is invariably denuded, rising in bosses all along the shore, and having the superposed beds lying unconformably upon it.

5th. The red clay (D), which is invariable in colour and constituents, shows, to my mind, an undoubted change of conditions in the land during the period of its deposition, being, as I conceive, the result of extensive denudation in more northern regions, spread over the sea-bottom by currents, the scratched pebbles and boulders being due to melting or stranded icebergs. I have thus endeavoured to point out, that with such different constituents for these beds, it is time to adopt some more definite names than the general one of "*Boulder-clay,*" which is commonly applied to the *series*. Until we know, for instance, in which of these *beds* particular rocks in the form of boulders are found, such a discussion as that which followed Mr. Morton's paper is useless, as what is referred to by one man as

Boulder-clay may be entirely different from that referred to by another. This, too, may be illustrated by Mr. Harmer's section of the Eastern Glacial and Post-glacial beds, where, as you saw, and in which I am happy to confirm him from personal observations in Holderness,[1] as clearly distinct a series of beds occurs, as that I have just described. I differ from him and Messrs. Rome and Wood, in considering the beds above the Grey Chalk clay Glacial, there being on the chalk clay as distinct a denudation and unconformability as in the bed F, in the Llandudno sections. Possibly our variance may arise from want of a more distinct definition of the meaning of the term "Glacial." I agree with Mr. Hughes in the opinion he expressed yesterday, that the time is not yet come, when the beds of the eastern and western Drift series should be correlated; but I think I already see evidences of a greater possibility of correlating them, than some of the workers in the eastern districts (whose untiring zeal in the elucidation of those beds is above all praise) are willing to admit.

Note.—In the paper on Holderness already referred to, I insisted on the "Grey Clay," as the only "true Glacial Boulder-clay," and which my subsequent observations have only served to confirm.

General Section of Drift in neighbourhood of Llandudno.

A	Sand-dunes. Thickness very unequal.
B	Blue-black clay without pebbles, 1 foot.
C	Sands and gravels, about 50 feet.
D	Red clay, greatest development about 20 feet.
E	Sands and gravels, greatest development about 20 feet.
E^2	Stratified grey clay, 20 feet.
F	Boulder-clay, greatest development 160 feet.
G	Mountain Limestone Rubble, 3 to 5 feet.
H	Bedded Mountain Limestone.

V.—On the Formation of Swallow-holes, or Pits with Vertical Sides, in Mountain-limestone.[2]

By L. C. Miall, Esq.

The geologist who rambles through the Mountain-limestone district of Yorkshire is sure to have his attention arrested by the numerous "swallow-holes," or pits, in the rock, into which rills, streams, or even rivers precipitate themselves; and if he can bring his mind to consider the subject sufficiently, without dismissing it at once by a reference to some vague natural force, he will come to perceive the somewhat complex conditions which a complete explanation must satisfy.

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[1] See Drift sections of the Holderness Coast, read before Liverpool Geological Society, Dec. 11, 1866, and published in their Proceedings.

[2] Read in Section C. of the British Association, Liverpool, September, 1870.

The feature which is most likely to impress him, from the number of examples which he will meet with in a small area, as well as from its rarity in non-calcareous strata, is the perpendicularity of the sides of these cavities. The drift and alluvium at the surface may have converging slopes, beds of shale intersected by the chasm will only rest at low angles, but a swallow-hole in a thick-bedded limestone has commonly vertical sides, and the weathering which it undergoes daily does not tend to derange its general shape. We cannot, I think, dispose of this peculiarity by a summary reference to the action of carbonic acid dissolved in rain-water. It is necessary to show further why that force, or any other concerned, should produce (but only under conditions which are rarely united) a kind of vertical denudation.

When we collect all the facts of observation which relate to swallow-holes, we find that the significance of some of them is not immediately obvious. We recollect many examples of these pits which have fluted sides, and some have also fluted pillars standing upright in the midst. We notice that they are very commonly sunk through a layer of drift or alluvium, which forms a funnel-shaped mouth, and often chokes up the bottom. They generally receive a stream of water, and always have an outlet, so that they never fill during rain. They commonly occur near the outcrop of a bed of limestone, as might be expected from the greater exposure of the rock at such points to denuding agents.

It is not often that swallow-holes are sufficiently accessible to render a minute examination easy. Some of the largest in Craven, such as Thund Pot and Hellen Pot, are difficult to approach, owing to the steepness of the drift slopes. There are easily-explored swallow-holes, which are nearly filled with débris, and present only a conical pit with grass-grown sides. But there is one spot which offers every advantage to the inquirer. Near the mountain-road which leads from Hawes at the head of Wensleydale to Muker in Swaledale are several of these pits close together. Their fancied resemblance to churns has acquired for them the local name of "Buttertubs," and the adjoining road is called Buttertubs Pass. Here we find a number of perpendicular excavations in the main limestone of the Yoredale series. The limestone is here about 75 feet thick, and the pits pass downwards from near the top of the bed to its base. They are striking examples of one form of the swallow-hole, and present peculiar details which it is not easy to interpret. Some of them receive runlets of water, others are dry. The sides are vertical, and generally fluted. We observe fluted pillars also, and remark that the surface of the ground is covered with drift. On one side is a narrow ravine with a steep face of rock, a few yards from the Buttertubs. The surface of the limestone near the edge is bare, or nearly so, and we thus get a good view of the cavities from level ground, and can approach or enter them from that side. The floors of most of the pits are covered with débris and rounded pebbles (chiefly of sandstone), which appear to be derived from the drift, and, ultimately, from a bed of grit (the ten-fathom grit), about 150 feet above the main limestone. The water which enters the holes penetrates the limestone horizontally, and escapes beneath it over a ledge of grit.

We have, therefore, in these Buttertubs many features worthy of notice, and unusual opportunities of investigation. I have endeavoured to satisfy myself as to their origin, and shall now offer some remarks on the principal difficulties which suggest themselves. It will be convenient to regard them as the type of that kind of swallow-hole whose mode of formation I shall first describe. It will afterwards appear that there is another and quite distinct sort of swallow-hole, whose walls are only fluted in a few instances and to a trifling extent. They seem to be due to a different set of causes altogether.

On searching for some indication of the way in which the Buttertubs had been formed, I was led to examine a miniature swallow-hole, near the road. Here is a little grotto overhung by turf, which mats together the clay and pebbles of the drift. From this spongy roof water drips incessantly upon a ledge of rock two feet below. It has excavated a concave surface or cup, which contains a number of small pebbles smoothed by friction. These pebbles are not of limestone, but of sandstone, and probably come from the ten-fathom grit, which makes a low escarpment higher up on the side of the glen. We hear the rattle of the pebbles amidst the plash of the falling water, and recognize in the sound evidence of continual abrasion; slow indeed, but more rapid than the action of water upon a uniform surface. The ledge is being gradually lowered, and as the excavation proceeds it leaves a scar upon the face of the limestone wall, semicylindrical and with sharp edges, such as would be cut by a gouge. Close by are a score of similar grooves, all formed in the same way; some long completed, but still sharp and clear, others now in process of excavation. Elsewhere we see the same force at work on a larger scale, but a little disguised by accidents of situation or of rock-form, and we find in these cascades, nourished by the accumulated moisture of a retentive soil, and aided in their work by the pebbles which have fallen into the basin, a possible source of the flutings which cover the vertical faces of the pits and of the isolated pillars.

Further observation justifies the conclusion that these large and deep cavities are indeed thus produced, but questions and difficulties arise which can only be removed by an examination of the details in the closest manner. The regular supply of dripping water from the same point, the connexion of the pits with joints or fissures, and the association of some of their most remarkable features with one kind of rock, and one only,—these all require elucidation before we can fully understand how so insignificant a cause can lead to such conspicuous results.

I do not recollect an example of a swallow-hole of this kind where the surface around has not been covered with alluvium or drift to a considerable depth. On a bare limestone plateau, such as the edge of Malham Cove, and also in non-calcareous strata, the joints weather into fissures, often broad and deep, and we may find flutings of various sizes formed as channels for trickling water, but the pits do not assume the same shape, nor are the flutings vertical and sharp-edged. The similarity of these two kinds of excavations is of a very general kind; and when we come to details it is soon clear that the Buttertubs, for instance, are due to causes less simple than the mere abrading or dissolving action of running water. Constant drip from a tolerable height upon the same place, and the friction of loose pebbles in the receiving basin, appear to be necessary to the production of their characteristic features, and these agents of waste are traceable to the thick alluvial covering. Its absorbent character enables it to act as a sponge, retaining the rainfall, and distributing it slowly and regularly. The overhang of the turf gives the drops an uninterrupted fall, and the sand and pebbles which fall from it help to grind the concave surface below. In some cases I have noticed that on the sides where drift still lies thick the flutings are sharp and still forming, while in another place, where the edge of the pit has been long bared, we have a face of rock weathered irregularly, and losing its grooved appearance till it passes into a plain limestone escarpment.

We must not forget the important influence exerted by those vertical divisions of the rock, formed subsequently to deposition, which are known as joints. In mountain limestone these are commonly conspicuous, though not close-set, except in a thin-bedded stratum, and they are more regular than in most sandstones. Limestone is rarely false-bedded, and its homogeneous character favours the production by expansion and contraction of rectangular dividing planes. To these crevices rain and air get access, and enlarge the cracks into fissures. The edge of many a limestone cliff is thus broken up into cubical blocks, and this is all when the sole weathering agent is equally-distributed rainfall. But when the drip from a spongy mass of alluvium and turf forms the little cascades described above, we have a tendency to produce new and irregular forms by the repeated excavation of semicylindrical grooves in various parts of the vertical faces of rock. The pit enlarges uncertainly, but generally tends to a circular form, leaving now and then isolated pillars, which may rise from a ledge in the pit or from the floor itself, according as they have or have not continued to be acted upon in the same way as the surrounding masses. A small pillar from which the cap of alluviun has been swept, while the swallow-hole has not ceased to grow deeper, shows, by its attachment to the adjacent rock at a greater or less depth, when its base has been removed from the general waste. What happens after this depends upon the accidents of the place. The swallow-hole may enlarge indefinitely, following the course of the principal fissures or extending itself independently, and becoming more or less circular. In other cases its enlargement is arrested by the fall of the alluvium, or by the collection of the rainfall into one channel. Its sides become less uniformly vertical, the frost detaches blocks of stone, and we get a shallow pit filled with loose rocks and pebbles, and often grass-grown.

Subterranean channels are exceedingly common in a Mountain-limestone district. They are generally, and no doubt correctly, assigned to the action of water passing along fissures of the rock. These concealed water-courses appear to be necessary to the formation and preservation of every sort of swallow-hole. They carry off the grains of sand and particles of mud which would otherwise accumulate so as to check further excavation, and may help to enlarge the pits by their undermining action, causing an occasional slip or subsidence.

It remains to consider why these singular cavities occur only in Mountain limestone. It will be seen that three conditions at least are essential:—1st. Abundant jointing, which facilitates the production of fissures; 2nd. Ready escape of water, which is partly effected by the fissures, and partly by the power of rain-water, to excavate calcareous rock; and, 3d. Alluvium or drift to discharge the collected rain in a suitable manner. The last of these conditions may be present in any place, irrespective of its stratigraphical character; the fissured structure occurs in many rocks other than limestones, but is rarely so conspicuous as in Mountain limestone, which is also peculiarly porous, owing to the solvent action of rain-water, charged with carbonic acid, upon carbonate of lime. The homogeneous character of that rock, too, enables it to be cut readily into definite shapes. For the same reason that a crystalline marble yields to the chisel more accurately than a stratified sandstone or flagstone, it obeys the abrading forces of nature more completely, and exhibits upon its hard and compact surface sharp grooves which have been cut in it by water or agitated pebbles. I show here a specimen of limestone from the brook below the Buttertubs, in which we see cut distinct and sharp the channels of the little streams which have been deflected right and left by a minute projecting fragment of shell or encrinite. Hard as it is to wear, the absence of definite arrangement in its texture renders it ready to assume the precise form which the slight inequalities of pressure and friction tend to impose. Granite does not produce such swallow-holes as these, because it is too impervious to water[1]—its cavities (unless they are merely enlarged fissures) are occupied by pools, and not by cascades. Chalk is too crumbly to preserve a vertical face against falling water,[2] while sandstones, flagstones, and slates are fissile, and conduct the rills along channels which take the direction of the planes of readiest decomposition rather than of the lines of quickest descent.[3]

[1] In the discussion which followed, Prof. Ansted referred to swallow-holes occurring in granite in Sark and Cephalonia. Enlarged fissures and pits, which receive streams, are, doubtless, to be met with in strata of all sorts, but swallow-holes of the first class described in the paper, whose characteristic features are vertical sides, fluted surfaces, and isolated pillars, are believed by the author to be restricted to a few formations only.

[2] See Prestwich's paper on swallow-holes on the Chalk hills near Canterbury. Quarterly Journal Geological Society, x. p. 222.

[3] In the discussion Mr. H. Woodward cited the case of underground *rivers* in the

The kind of swallow-hole which I have just described is, in all important respects, comparable to the moulins of a glacier. We have in both the conditions of homogeneity of rock or ice, of many fissures, of a ready escape of water through or beneath the excavated mass, and of an equable supply of water over a considerable surface.

We come next to the consideration of the second class of swallow-holes, whose existence is due to subsidence of an undermined crust, and not to direct excavation.

Geologists are familiar with the long caverns of mountain limestone districts. In the majority of cases they are fissures enlarged by the running water which passes along them. Ingleborough Cave is upwards of 700 yards in length, and appears to traverse part of the course of two or three parallel fissures, the intervening rock being tunnelled through several times. Many instances occur of subsidence of a portion of the roof of such a cavern, and it is not uncommon to find several openings into the same subterranean channel. In Hellen Pot, near Horton, in Ribblesdale, there are at least three such shafts. When we find a long, irregularly arched, passage, sometimes opening into lofty chambers, and presenting at intervals large apertures, beneath which the floor is encumbered with great blocks of limestone, we naturally conclude that the cavern was first formed by a stream of water, and that weak parts of the roof have subsequently fallen in. This I believe to be the true interpretation. The sides of such chasms are only rarely and incidentally fluted; the aperture does not ramify irregularly along the course of the fissures: there are no isolated pillars. Many of them have no drip of water from the surface; others are worn to a slope or a spout on one side by the entrance of a mountain stream. Near Settle there is a slight depression in the ground at a place called Robin Hood's Mill. Here a rumbling noise is continually heard which resembles the rush of water underground. I imagine that at this spot is situated the expanded part of some hidden water-course, which may be sooner or later converted into a shaft by yielding of the roof.

Swallow-holes of this second species frequently occur in a line sometimes in a ring round a hill-side.[1] They are most abundant in the lower scar limestone, rarely occurring in the thinner limestones of the Yoredale series. The formation of the long caverns is favoured by the great horizontal partings which mark the scar limestone. In the regularity and great extent of these partings of the thick-bedded

Chalk beneath Norwich, which had been tapped by the deep-main sewers lately constructed, and which had proved almost insurmountable obstacles to the completion of the works. He also mentioned the case of a sudden sinking of land at Lexham, Norfolk, upon the farm of Henry Childs, Esq., leaving a deep circular depression in the field. A ploughman, plough, and pair of horses at work in the field were carried down with the land, but were providentially rescued, without harm, from a depth of twenty feet or more. Such pits, he remarked, were evidently the result of the falling in of the roof of one of these deep-flowing rivers in the Chalk beneath.

[1] Prof. Phillips mentions a glen formed by a line of ancient subterranean caverns. The subsidence of the roof appears to have originally determined the direction of the watercourse. See paper on Formation of Valleys near Kirby Lonsdale, British Association Reports, 1864.

limestone, we have a suggestion of deep sea deposition, as well as an explanation of the constant association with the lower scar limestone of cavities of subsidence.

We are not without direct evidence to show the possibility of the sudden formation of a pit by the fall of ground which had been undermined by water. About a mile to the north of Ripon, near the river Ure, are a number of pits or hollows, fifty to a hundred feet in diameter, and in some cases as much as seventy feet deep. They are commonly of conical shape, some are perpendicular shafts. The majority are sunk through the New Red Sandstone, which here overlies beds of Red Marl, gypsum, and Magnesian limestone. In a paper read before the West Riding Geological Society, the Rev. J. S. Tute has placed upon record several accounts given by eye-witnesses of the sudden production of these pits. In 1860 the Rev. F. H. Dunwell observed the falling in of a pit 69ft. deep and 22ft. wide. Twenty years ago one fell in at Sharrow during the night. Forty years ago a stack upon which some men were working, near Bishop Monkton, disappeared, and its place was occupied by a hole which still remains. These pits are undoubtedly due to the yielding of the ground above a large hollow or cavern, but the difficulties of observation are so great as to prevent a full comprehension of the circumstances of excavation. Mr. Tute is of opinion that the subterranean waste has gone on in the Red Marl and gypsum beds. I should myself incline to believe that caverns in the Magnesian limestone have undermined the ground.

In many parts of Craven, particularly in Chapel-le-Dale and Ribblesdale, there are stories of chasms suddenly formed, but I have as yet been unable to authenticate any of these accounts by the testimony of eye-witnesses. If attention is once called to the point, well-attested cases will quickly accumulate. (See note ante p. 518.)

It is easy to understand that swallow-holes formed by subsidence may be much disguised by the superficial character of the ground. Some of the large conical depressions without an outlet, which occur in a calcareous district, may be due to the yielding of undermined rock beneath a thick mass of drift. I am inclined to adopt this explanation of many basins which occur in the Glacial drift of Craven, especially with regard to such as are pervious to water. Some of the most remarkable of these occur near Kirby Lonsdale, at the entrance to Underley Park. I do not know that Mountain limestone underlies them, though it is plentiful close at hand, for the thick superficial deposits and the large faults which disturb the district render it unsafe to infer that such is the case. But the supposition is not improbable,[1] and if it should be confirmed, we may find in the hypothesis of concealed swallow-holes a less adventurous explanation of these singular excavations than one which has gained currency, viz., that large blocks of ice have been heaped round with drift, and afterwards melted. Around Ingleborough, and also near Silverdale, are many conical and dry pits in Glacial drift, where the subjacent strata are undoubtedly calcareous and frequently pierced by swallow-holes.

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[1] In the subsequent discussion, Mr. T. McK. Hughes, of the Geological Survey, gave his opinion that the strata beneath these hollows were Devonian and non-calcareous. He also supported the ice theory mentioned in the paper.

It is worth while to separate the two sorts of excavations which have been described. They are locally known as "buttertubs" and "pots." If it be necessary to find terms more precise and dignified, they may be distinguished as "cavities of erosion" and "cavities of subsidence."

VI.—ALTERED CLAY-BED AND SECTIONS IN TIDESWELL DALE, DERBYSHIRE.[1]

SIR,—The GEOLOGICAL MAGAZINE for August, p. 394, contains a report of a paper communicated by the Rev. J. M. Mello to the Geological Society, on the 22nd June, 1870, on the above subject. On the 7th September, 1869, I had the honour to read a paper on the same subject to the Natural Science Section of the Nottingham Literary and Philosophical Society. Hence I beg to claim priority in publication on behalf of the above Society. Apart from this, I, of course, do not complain that Mr. Mello should happen to select a very interesting section like that in Tideswell Dale, no doubt being quite unaware that I had already published an account of the same. The sole, though rather dubious, deduction that the author is reported to have made, is "that the columnar clay-bed may *perhaps* be a local development of that which forms partings in the limestone near Litton Tunnel." In my paper (extracts of which I inclose) I endeavoured to account for the clay-bed, or rather mass, in another way, and was at some pains to prove, or to try to prove, that the bed in question was not a thickened clay parting, much less a series of partings. I do not know whether Mr. Mello's paper is correctly represented by the very brief account you give, but the Section was of opinion that my paper deserved a full report.

I was so much interested in what I saw in one day's trip that I determined to visit the district again and examine the igneous rocks of the Derbyshire Carboniferous Limestone more thoroughly. The opportunity has not again occurred. I can, however, conscientiously recommend the task to those of your readers who are conveniently situated for the purpose or who have time at their disposal.

EDWARD WILSON.

HALL STREET, SHERWOOD, NOTTS., 10 AUG., 1870.

"On the west side of the Dale (Tideswell), at the same level as, and almost directly opposite the marble quarry, I found a very curiously filled up cavity in the limestone, exposed in the cutting of the road along the hill-side. At the base limestone, highly fossiliferous beds, two to three feet thick, minor joints confined to single beds; above lies an apparently imperfectly laminated band of yellowish clay, which, at one or two places, dips down into, and fills up, the space between the jointed limestone blocks. Into the largest of these clay-lined basins is protruded a tongue of vesicular toadstone (imperfectly columnar), and one side of the toadstone tongue is coated with a thickish mass of red clay, identical in texture with that found in the marble quarry (Fig. 2) and the district generally (see Fig. 1).

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[1] The publication of this communication has been unavoidably delayed from want of space.

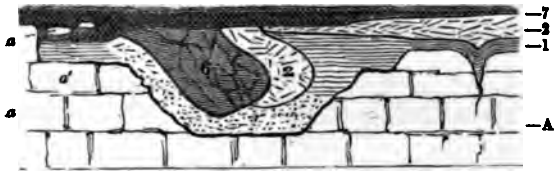

Fig. 1. Section in Tideswell Dale opposite the Quarry.

7. Surface soil.
6. Toadstone amorphous in B, slightly vesicular in A.
5. Vesicular do. *a*. Carboniferous Limestone.
4. Amygdaloidæ ? do. *a'*. Boulders of do. in surface soil.
3. Scoriaceous do.
2. Red clay mass 2*a* (Fig. 2) columnar portion.
1. Ash decomposed and rearranged, yellow friable argillaceous layers.

N.B.—The figures in both sections correspond. Fig. 1 has really a semicircular outline, like a small amphitheatre, but is represented as if it had a plane surface like Fig. 2.

Height of section 12ft., length 20ft. I hazarded the conjecture that the cavity was a natural irregularity in the Carboniferous Limestone sea bottom, that a volcanic eruption ensued, preceded by showers of ashes, that these latter sank, and being arranged by marine currents would naturally accumulate in the hollow, the eruption continued, a mud flow next ensued (the so-called red clay), just as rivers of mud have poured in modern times from Vesuvius, the volcanoes of Java, etc. This succeeded in forcing itself into the basins of ashy matter, and was in turn succeeded by the true, probably chiefly if not entirely submarine, lava (or toadstone) flow (or flows), which, on account of its greater density, forced a passage for itself, between the plastic clay and ash, as shown in the section, before hardening. Crossing the Dale we inspected the quarry. The base there was also compact horizontal coralline marble, about 6ft. exposed. Directly above comes a *mass* of deep red clay, 8ft., compact below, but in its upper portion taking on a very distinct columnar structure, the columns varying from 4 to 6 feet in length, and showing, in cross section, square pentagonal and irregular hexagonal forms. It appeared at first glance, on entering the quarry, as if a number of men had been working with the pickaxe in soft clay. Closer inspection, however, shows the regularity and a certain duplex contortion of the columns (see Fig. 2).

This band has not the slightest trace of lamination either in the columnar or non-columnar portion, but, on the contrary, is irregularly veined and streaked with a softer greenish-white scaly material, apparently of a chloritic or talcose nature. Above this lies a considerable mass of toadstone, which consists in ascending order of—

3.	Scoriaceous band, dark earthy and porous	0 ft. 4 in.
4.	Toadstone amygdaloidal blending into	0 ft. 2 in.
5.	Toadstone vesicular blending into	0 ft. 8 in.
6.	Toadstone amorphous basalt to surface (about),	16 ft. 0 in.

(the total thickness when undenuded must exceed 50 ft.)

"The entire section exposed would thus be about 31 ft. The columns, if exposed for some time to the atmosphere, weather to a colour similar to that of the toadstone (rusty iron with green blotches). The unweathered toadstone is here a dull olive green. The red clay mass is undoubtedly the continuation of that occurring in the previous section (Fig. 1), and I have proved, by finding fragmental columns in other portions of the Dale, that its development is coextensive with the toadstone in this locality. I am aware that there is an upper *clay* (?) band not represented in this district also in connexion with the toadstone; but I am not aware of any locality where these clay-bands are present and the toadstone wanting. I noticed that there were no clay partings in the limestone, though we do occasionally find thin clay partings in it; the thickest that I have ever heard of is only 8 inches, or not one-tenth the thickness of this clay band. There is, besides, no intermixture of shales, false bedding, or other impurity or irregularity in the strata, as in the more littoral South Derbyshire equivalents of the upper part of this formation; nor should we expect this, as in the neighbourhood of the High Tor, Derbyshire, the highest toadstone is covered by 150 feet of almost pure limestone, indicating the continuation of deep sea conditions for a considerable period after the formation of this *clay* (?)-bed."

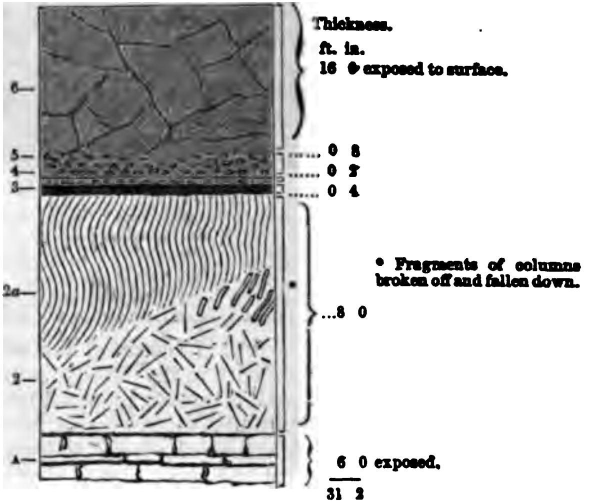

Fig. 2. SECTION IN QUARRY, TIDESWELL DALE, DERBYSHIRE.
(Explanation of figures same as in Section, Fig. 1, p. 521.)

Without entering more into details at present, I will select two quotations from Lyell, as bearing on this subject, contained in my paper:

"At the summit of the I. of Cyclops a mass of stratified clay with occasional arenaceous laminæ rests on (intrusive) columnar lava. In some places the overlying clay has been greatly altered and hardened by the igneous rock, *and occasionally contorted, but the lamination is rendered more conspicuous.*"

"In Madeira and the Canary Islands, streams of lava of subaërial origin are divided by bands of red laterite, probably ancient soils formed by the surface-decomposition of lava currents; many of these owe their red colour to atmospheric action on the oxide of iron, but *others are burnt into a red brick by the overflowing of heated lavas.* These red bands are sometimes prismatic, the small prisms being at right angles to the sheets of lava."

I believe the only plausible alternative to my view is that these red clay bands are either greatly decomposed and rearranged ash or lava accumulations, but if this were the case, should we not expect to find a certain intermixture of organic remains, for corals are found actually projecting into the ashy matter of the first section, and are most plentiful on the same horizon as this cavity and in the beds above the toadstone. E. WILSON.

NOTICES OF MEMOIRS.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. FORTIETH MEETING. LIVERPOOL, 1870. PAPERS READ IN SECTION C. (GEOLOGY.)

President.—Sir PHILIP DE MALPAS GREY EGERTON, Bart., M.P., F.R.S., F.G.S.

G. H. Morton—On the Glaciated Condition of the Surface of the Triassic Sandstone around Liverpool. (See page 525.)

Dr. Ricketts—Section of Strata between Huyton and St. Helens.

J. Thomson—Report of Committee for Photographing and preparing sections of the Corals of the Mountain Limestone.

W. H. Baily—Report on Fossils of the Kiltorcan Quarries.

W. S. Mitchell—Fourth Report of the Committee Appointed to Investigate the Leaf-beds of the Lower Bagshot Series of Hampshire.

G. Maw—On the Evidences of Recent Changes of Level on the Mediterranean Coast.

W. C. Williamson—On the Organization and Affinities of the Calamites of the Coal Measures.

W. Carruthers—On the History and Affinities of the British Coniferæ.

Prof. Duncan—Report of Committee on British Fossil Corals.

Dr. Leith Adams (read by G. Busk)—New Species of Elephants.

W. Pengelly—Sixth Report of the Committee for the Exploration of Kent's Cavern, Devonshire.

Prof. Hull—On the Extension of the Coal Fields beneath the newer formations of England.

H. Woodward—Notes on Fossil Crustacea.

Dr. Bryce—Report of Committee on Earthquakes.

G. A. Lebour—On the Tertiary Coal Fields of Southern Chile. (See page 499.)

Prof. Phillips—Notice of Mammalian Jaw from the Stonesfield Slate.

Prof. Stokes—Report of Hæmatite Committee.

Prof. Harkness and *H. A. Nicholson*—On the Green Slates and Porphyries of the Lake District.

C. Lapworth—On the Discovery of Upper Silurian Rocks in Roxburgh and Dumfriesshire.

J. W. Judd—On the Age of the Wealden.

Rev. W. S. Symonds—On the Physical Geology of the Bone Caves of the Wye.

Dr. Moffat—On Geological Systems and Endemic Diseases.

Report of Committee on Sedimentary Deposits of River Onny.

J. Gwyn Jeffreys—Remarks on Newer Tertiary Fossils in Sicily and Calabria.

Prof. Ansted and *Prof. King*—Notes of a Recent Visit to the Great Tunnel through the Alps, and of Several Points of Geological Interest, suggested by the condition of the works in the present nearly complete state.

Prof. King—On some Points in the Geology of Strath, Isle of Skye.

W. Pengelly—The Modern and Ancient Beaches of Portland.

J. E. Taylor—On the Occurrence of Seams of Hard Sandstone in Middle Drift of East Anglia.

F. W. Harmer and *Searles Wood*—On the Palæontological Aspects of the Middle Glacial Formation of the East of England, and on their bearing upon the Age of the Middle Sands of Lancashire.

Rev. H. W. Crosskey—On Certain Glacial Phenomena in the Central District of England.

F. W. Harmer and *Searles Wood*—On some Thermal Springs in the Fens of Cambridgeshire.

Dr. Bryce—On the Matrix of the Gold in the Scottish Gold-fields.

W. S. Mitchell—Some Remarks on the Denudation of the Oolites of the Bath District.

W. Carruthers—Note on an Antholites Discovered by C. W. Peach.

W. Carruthers—On the Sporangia of Ferns from the Coal Measures.

G. H. Morton—On the Mountain Limestone of Flintshire and part of Denbighshire. (See page 526.)

L. C. Miall—On the Formation of Swallow-Holes, or Pits with Vertical Sides, in Mountain Limestone. (See page 513.)

A. R. Wallace—On a Diagram of the Earth's Eccentricity and the Precession of the Equinoxes, illustrating their relation to Geological climates and the rate of organic change.

J. L. Lobley—The Stratigraphical distribution of the British fossil Gasteropoda.

R. Tate—A Census of the Marine Invertebrate Fauna of the Lias.

Rev. J. Gunn—On the formation of Boulder Clays and alternations of level of land and water.

C. Jecks—On the Red and Coralline Crags.

G. J. Stoney—On some cases of the recent conversion of Glacial Drift into what appears to be Middle Drift.

H. F. Hall—On the Glacial and Post-Glacial beds in the neighbourhood of Llandudno. (See page 509).

J. Thomson—On the Occurrence of Pebbles and Boulders of Granite in Schistose Rocks in Islay, Scotland.

Professor Tennant—Diamonds of South Africa.

R. A. Peacock—Changes of Climate.

Professor C. Malaise—**Sur le terrain Silurien du centre de la Belgique.**
W. Carruthers—**Remarks on the Fossils from the Railway Section at Huyton.**
T. A. Readwin—**Notes on a Merionethshire gold quartz crystal, and some gold found recently in the river Mawddach.**

I.—THE GLACIATED CONDITION OF THE TRIASSIC ROCKS AROUND LIVERPOOL.[1]

By G. H. MORTON, F.G.S., etc.

REFERRING first to the general geology of the neighbourhood of Liverpool, Mr. Morton said that considerable attention had been directed to it since the former meeting of the British Association in the town, in 1854.

At that meeting, Mr. Edward Hull, F.G.S., exhibited the first authentic section of the Triassic strata across the district which he had then just surveyed. The map of the Government Geological Survey, published immediately afterwards, was of great value to local geologists; and although sixteen years of continued observations render a few corrections necessary, they were of a trivial character, and not of sufficient importance to bring before the Section. A deep railway cutting has very recently opened a portion of the Middle (or productive) Coal strata between Rainhill and St. Helen's, and an extraordinary variety of Carboniferous plants and fish remains have been found. The most important progress, however, in local geology, has resulted from the examination of the superficial or Drift deposits which cover the country, and the discovery of the glaciated condition of the surface of the Sandstone beneath.

It was to the latter subject that Mr. Morton now drew special attention. After pointing out the sub-divisions of the Glacial and Post-glacial Deposits, he remarked that it was only when the Boulder-clay has overlain the striated rock, that the scratches were preserved. This Boulder deposit is the dark-red clay so extensively used in the neighbourhood for brick-making. It seldom contains fragments of local origin, but always hard rocks, such as quartzite, granite, greenstone, basalt, and slate.

In 1859, Mr. Morton described, for the first time, to the Literary and Philosophical Society of Liverpool, evidences of the action of ice on the Sandstone in this neighbourhood. Having at that time only found such indications in a single locality, he attributed the striated surface to the grounding of an iceberg in the Glacial sea. In 1866, having found several additional examples of this glaciation on both sides of the river, but at no great distance from it, he began to entertain the opinion that a glacier had descended the valley of the Mersey during the early part of the Glacial Period, and made a communication to that effect to the Liverpool Geological Society. Lately, however, he had discovered similar evidences of ice-action at greater elevations, several miles from the river, and had consequently been compelled to adopt a new theory, which is, that a great sheet of ice once travelled over this part of the country, from the S.E. towards the N.W. The course of the ice seems to have been only slightly influenced by the inequalities of the ground. It was when the land was higher than it is now, and, consequently, when there was a longer slope towards the Irish Sea.

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[1] Read before the British Association (Section C.) at Liverpool, September, 1870.

The localities exhibiting striated surfaces, were indicated on a map, the most distant being about nine miles from Liverpool. They naturally grouped themselves into six areas, each of which Mr. Morton very carefully described, and they occurred indifferently on the Bunter and Keuper divisions of the Trias.

Assuming the glaciation of the surface of the rocks around Liverpool to have occurred before the submergence of the land at the beginning of the Glacial Period, and afterwards covered with Boulder-clay, deposited by icebergs or field-ice, some portions must have been denuded during the subsidence, though the denudation that took place seems to have been inconsiderable. The only alteration in the contour of the land seems to have been the reduced elevation of the low ranges of hills, which traverse the district in the same direction as the ice seems to have done. It is a singular coincidence that the strike of the strata is the same as the supposed course of the ice, and that the form of the ground may be accounted for, either by rain and rivers, or, by the scooping power of ice. The direction of the hard Sandstone ridges, with intervening valleys in the softer strata, would support either conclusion.

Finally, there was little doubt that the country around Liverpool was once covered by a great ice-sheet, at a time when the land was some hundreds of feet higher than it is now, and that it afterwards subsided beneath the sea, when floating ice brought from the hills of the lake district and Scotland débris, which became scattered over the ice-grooved rocks in the form of Boulder-clay.

II.—ON THE MOUNTAIN LIMESTONE OF FLINTSHIRE AND PART OF DENBIGHSHIRE.[1]

By G. H. MORTON, F.G.S., etc.

MR. Morton pointed out that in Flintshire, within fifteen miles from Liverpool, there is a prominent ridge of Carboniferous or Mountain Limestone. It extends continuously from Prestatyn on the coast of Wales to Llandegla, a few miles north of Llangollen, the distance being twenty-one miles, and the strike of the limestone N. by S.E. and S. Instead of a general description of the formation, he had selected what appeared to be the four most favourable localities as centres of observation: Mold, Holywell, Newmarket (Flintshire), and Llangollen. He alluded to the country around or hese places, for neither Mold nor Holywell are actually upon ountain Limestone. Llangollen was included because of the section presented by the Eglwyseg rocks, about a mile from wn.

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[1] Read before the British Association (Section C.) at Liverpool, September, 1870. See also a paper on the Millstone Grit of the North Wales Border, by D. C. Davies, GEOLOGICAL MAGAZINE, Vol. VII., 1870, pp. 68, 122.—EDIT.

estimated thickness of the Limestone was 1,200 feet. The one Grit of the Geological Survey succeeds the Limestone, and at 800 feet thick, coal being worked above it at Tyfynuchaf.

mile and a half to the west of the town of Mold there is a ction of the Mountain Limestone. The vertical section of the at Newmarket is compiled from three horizontal sections each show the thickness of a subdivision. The upper, middle, wer limestones are on the surface disconnected by faults, but lative geological position of each is obvious. The lower grey lack limestones rest on Silurian strata, and are 750 feet thick el Hiraddug. The white limestone ridge, 350 feet thick, is lifferent from any of the Hiraddug strata, as it also is from the and grey limestone and shales, 300 feet thick, which crop out under the overlying shales and sandstones of the Millstone Consequently the white limestone of Axton occupies an ediate position, which was confirmed by the fossils it con- Appended to Mr. Morton's paper was a list of ninety-four found in the district which he had described, and which showed nge of the species through the three (upper, middle, and lower) ns of the Carboniferous Limestone. When the number of s is considered, the upper and middle divisions are seen each ve many peculiar fossils, and an undue distinctive character be supposed to separate them. But when the relative abun- of the species is considered, this distinction is not marked, for mmon forms have a considerable range, while the rare ones ore or less restricted.

analysis of the list showed some interesting results. Ex- g a few fish teeth and scales, and plants, all of which occur in pper limestone, it appeared that the lower limestone does not n any species peculiar to it, for some of them extend upwards the white or middle limestone, whilst others pass up to the st subdivision. The earlier species, principally found at the of Moel Hiraddug, are *Spirifera lineata* and *Syringopora reticu-* and they continue upwards through the whole of the Mountain tone. These two species, with a *Lepidodendron* and another , seem to have been the first colonists that settled down in the niferous sea of North Wales. The middle or white limestone nts twenty-eight species which are peculiar to it (of course on species elsewhere), but of these no less than twenty-three only been found in the limestone ridge at Axton, Newmarket. assemblage of species in such a limited area was extraordinary. e upper limestone, twenty-three species have been found to be iar to it, but they are all of rare occurrence, only single speci- having been found of about half of them.

REVIEWS.

I.—SCIENTIFIC RESULTS OF A JOURNEY IN BRAZIL. By LOUIS AGASSIZ, and his travelling companions. GEOLOGY AND PHYSICAL GEOGRAPHY OF BRAZIL. By CHAS. FRED. HARTT, Professor of Geology in Cornell University. 8vo. pp. 620, with numerous illustrations. London: Trübner & Co., 1870.

THE reader who takes up Professor Hartt's book, expecting to find therein only a sketch of the Geology and Physical Geography of Brazil, will be agreeably disappointed; for the six hundred and twenty well-stored pages contain much else than can be rigidly construed as belonging to either of these departments of Natural Science. Professor Hartt was not content with his gleanings in Brazil, made during the brief period occupied by the "Thayer Expedition" under Professor Agassiz, but he returned and made a second exploration, in order to continue, and as far as possible complete, his first investigations.

If we mistake not, we suspect Professor Hartt is even more at home in a dredging expedition than in a stone-quarry, and the book before us betrays the spirit of the ardent zoologist, quite as much as that of the geologist or geographer.

Nor are we disposed to find fault with this, for, by aid of the author's wider knowledge, we see and learn much more of the Brazilian Empire than we should otherwise have done from a mere "stanecracker," as the Scotch country-folk call geologists.

The "Thayer Expedition" was undertaken in the years 1865 and 1866. "On this journey," says Professor Hartt, "I studied very carefully the Geology and Physical Geography of the coast between Rio and Bahia, going over a very large part of the ground on horseback or in canoe." "My companion," he adds, "was Mr. Edward Copeland, of Boston," whose services are duly acknowledged. During this journey, the author made very large collections of marine invertebrates and fishes, nor did he neglect to secure other objects of Natural History. Mr. Hartt adds, "My studies of the stone and coral reefs, and of the geology of Brazil, proved so very attractive to me, that on the year following I returned to Brazil and spent my vacation, several months, in examining the coast between Pernambuco and Rio, exploring more particularly the vicinity of Bahia and the islands and coral-reefs of the Abrolhos."

The present volume was originally intended only as a report to Professor Agassiz as Director of the "Thayer Expedition," to embrace simply the results of Mr. Hartt's explorations as geologist to that expedition, and his subsequent journey to Rio, etc. But the delay in publication has given Mr. Hartt the opportunity to examine the existing literature on Brazil; and thus, from a simple account of his own investigations, his book has grown to be a general work incorporating the chief results of others who have written on the Geology and Physical Geography of the Empire.

It would be impossible, in our limited space, to give more than a very brief notice of Prof. Hartt's book; we will therefore gather a few of the geological results it makes known.

The oldest (*Eozoic*) rock observed appears to be fundamental gneiss. Gneiss is found in every province of the Empire. It forms the great coast-belt extending from Maranhão to the mouth of the Rio de la Plata, but it sends off a band from southern Minas Geraes into Goyaz, and the Montes-Pyreneos, and a considerable part of the mountainous region of Central Goyaz are composed of it. The same rock is seen in the cataracts of the Tocantins, the Xingú, the Tapajos, the Arinos, and the Madeira, showing that the Table-land of Brazil is everywhere underlaid by it.

As these rocks are highly inclined and full of reversed folds, as in Canada, it is quite impossible to approximately estimate their thickness.

Dr. T. Sterry Hunt, who has examined with care a large suite of Prof. Hartt's specimens of metamorphic rocks, considers that they "present the characteristic types of the Laurentian of North America, including as they do coarse granitoid and porphyritic varieties, with red orthoclase and fine-grained grey and white-banded gneisses, often hornblendic. The white crystalline limestone, with pale green serpentine, which occurs with these Brazilian gneisses, is not distinguishable from that of the North American Laurentian."

Dr. Hartt believes that the clay and talcose schists, the itacolumite, itabirite, and other associated metamorphic rocks of the gold-region of Minas Geraes, are of Lower Palæozoic age (Silurian), and he suggests that they may be equivalent to the Quebec group of North America.

Clay-slates, with auriferous veins, occur in other parts of Brazil besides Minas, as, for instance, in Goyaz, and in the vicinity of Cuiabá in Matto Grosso. These rocks are everywhere so metamorphosed, that all trace of fossils has been completely obliterated.

Some of the metamorphic rocks of Minas Geraes or Bahia, the author thinks, may be Devonian, but he saw no rocks referable to that age upon the coast, unless, indeed, the slate conglomerates, sandstone, and shale, with fossil plants, found on the Rio Prado, may belong to it.

There can be no uncertainty about the existence of true Carboniferous strata in Brazil, for besides the Coal, we have an abundance of fossil plants of Carboniferous genera. The true age of the Brazilian Coal-beds on the Rio Candiota, Rio Grande Do Sul, explored by Mr. N. Plant, F.G.S., was satisfactorily determined on the evidence of the plant-remains by Mr. W. Carruthers, F.L.S., F.G.S., of the British Museum (See Geol. Mag., 1869, Vol. VI. p. 151, Plates V. and VI.).

The Coal-basins lie just south of the tropics, but within the range of the palm, and they are a coast-formation, corresponding in this respect to the Coal-basins of Acadia, Massachusetts, and Rhode Island. Coal-strata do not seem to occur north of Rio on the coast. The beds of Coal appear to have been but very slightly disturbed, and to be bituminous in character.

A large area in the Province of Sergipe is occupied by a thick series of red sandstones (apparently barren of fossil-remains), and lithologically identical wlth the Connecticut River and New Jersey New Red Sandstone. The author refers these to the Triassic epoch.

During the Jurassic period. the Brazilian coasts would appear to have been elevated lands. like Eastern North America, as no rocks of Jurassic age have as yet been observed.

The Cretaceous rocks of Brazil begin a few miles south of the Bay of Bahia, and occur at intervals along the coast northward, occupying several separate basins, seme of which are fresh-water. Their extent is uncertain. as they are largely covered by Tertiary beds. Probably marine Cretaceous beds underlie the Tertiary deposits throughout the whole valley of the Amazons; they are only exposed. however. on the Aquiry. an affluent of the Rio Purus, where they were examined by M. Chandler.

The fossil mollusks of the freshwater beds of Bahia have a very strong Wealden aspect. An account of this deposit will be found in the Quart. Journ. Geol. Soc., Lond., vol. xvi. p. 263. given by Mr. S. Allport, with notes on the fossils by Prof. Morris. Prof. Owen, etc.

Mr. Hartt proposes the following classification for the Cretaceous rocks of the Brazils: "Amazonian group" (Aquiry), with ***Mosasaurus***; Mæstrichtien?. "Cotinguiban group." with ***Inoceramus***, ***Ammonites***, etc., Sénonien?. "Sergipian group," with ***Ammonites*** and ***Ceratites***; Middle Cretaceous?. "Bahian group," ***Crocodilus***. ***Pisodus***. ***Melania***, Cyprids, etc., Néocomian?.

Two sets of Tertiary Clays and Sandstones are described. one forming the coast-plains outside the *Cordilheira*. and overlying the Cretaceous beds unconformably; the other series occupying the Jequitinhonha and São Francisco valley, and resembling the coast-clays, save that they are thicker. stand at a very much higher level. and in some cases form beds of pure sandstone and conglomerate. with limestone and iron ore. These higher beds are also covered by drift-clays. Another deposit known as *Tapanoacanga*. "consisting of angular or rounded fragments of micaceous iron and other rocks. cemented together by an ochreous paste, which sometimes exists without the gravel." This deposit is said to wrap round the highest mountains like a mantle.

At Minas Novas and elsewhere gold is mined in a similar gravel (called *cascalho*) composed of rounded quartz pebbles. etc.. with a ferruginous cement, and overlaid by a bed of clay.

This same sheet of quartz pebbles and overlying clays covers all the Province of Rio (except the flat alluvial plains bordering the coast) to the tops of the highest hills. The deposit is said to be everywhere *unstratified*. The same layers extend over the provinces south of Rio. Near Rio and elsewhere, occur deposits of immense boulders of trap, gneiss, etc., which Professors Agassiz and Hartt consider to be evidently morainic, and the work of local glaciers; and Professor Agassiz has described similar moraines as existing in the Province of Ceará.

The agent invoked by the learned Professors for the formation of this vast deposit of structureless clays, gravels. and boulder-deposits. *Glacier Ice.*

This startling theory has of course been much disputed. We ourselves pointed out grave reasons for receiving it *cum grano salis* (See GEOLOGICAL MAGAZINE, [illegible] Vol. V. p. [illegible] Review of a Journey in Brazil: by Prof. and Mrs. L. Agassiz). That caution still holds good—Avoid hasty generalization. "Is one year's search over hundreds of thousands of square miles to be considered exhaustive? We think not." [illegible] "Nowhere," writes Prof. Hartt, "over the whole region [illegible] by the drift do we find other water-deposits than those bearing reference to the action of rivers or lakes. Above the old sea-levels of [illegible] Bahia, etc., there are neither raised beaches nor any other testimony of the action of the sea."

Space will not admit us to deal with the work before us at greater length; but we have cited sufficient to prove its great value and that its author, Prof. Hartt, is an able and [illegible] observer and a worthy associate of Prof. Agassiz. That he should defer to the views of his chief is only natural; but we hope he will be induced by the love he feels for Brazil to go there yet again and find more geological evidence before insisting on Agassiz's Glacial theory. *Stratified beds*, with abundance of Fresh-water and Estuarine shells, appear to have been met with by another observer, Prof. Orton, whose letter we publish in our Correspondence this month (p. 540). We congratulate His Majesty the Emperor of Brazil upon another most interesting contribution made to a knowledge of his country by an English-speaking foreigner.

II.—THE GEOLOGICAL SURVEY OF THE UNITED KINGDOM.

[Annual Report of the Director-General of the Geological Survey, the Museum of Practical Geology, the Royal School of Mines, and the Mining Record Office, for the year 1869.]

WE have just received the official annual report of Sir Roderick I. Murchison, Bart., Director-General of the Geological Survey; and although much progress has doubtless been made since the report was prepared, it may be interesting to note the state of the Survey at the close of last year.

In England and Wales, Professor Ramsay, the Director, reports that during the year 1869 a total area of [illegible] square miles was surveyed, which involved the tracing of [illegible] miles of boundary lines of formations. In Cumberland, Westmoreland, Yorkshire, and Lancashire, much work has been done; the mapping of the Lancashire coal-field has been finished, and the main coal-fields of Yorkshire have also been traced out.

In Durham and Northumberland the Survey [illegible] being carried on, and the mapping of the important northern [illegible] will, it is thought, be finished during the ensuing year.

Portions of England, Lincoln, Northampton[illegible] Cambridge, and Essex have been surveyed, while [illegible] in Somersetshire the Rhætic or Penarth Beds have [illegible]

Perhaps the most interesting statement of the announcement that a considerable tract around London, including the gravel, brick-earth, alluvium, and drift, is in course of being surveyed.

In Scotland, Mr. A. Geikie, the Director, reports that a considerable advance has taken place in the amount of ground surveyed, in comparison with the return of the previous year, the additional area amounting to 111 square miles.

The general survey is proceeding from the high grounds of Dumfries and Kirkcudbright, already examined, to the lower country southwards towards the Solway Firth, and in an easterly direction, passing over Nithsdale and Annandale. This work will unite the existing labours with those of former years in Peebleshire and Selkirkshire. The surveys of the coal-fields of Douglas and Sanquhar, and of the mineral district of the Lead Hills, have been completed.

Sir Roderick reports that short Memoirs, explanatory of the sheets on the one-inch scale, are now issued regularly with every new map of the Scottish Survey, at the small cost of threepence each, and that similar descriptions are preparing of the previously issued maps which were published without such information.

In Ireland, Prof. Edward Hull, Director, reports very satisfactory progress. 797 square miles were surveyed, and 1,742 boundaries traced during the year. The work is now being carried on in Galway, Mayo, Roscommon, Longford, and Down.

Several Index-maps accompany this report to show the state and progress of the Survey.

England is divided into 110 sheets on the one-inch scale. Of these, sixty-nine whole sheets and eleven quarter-sheets have been published; of the remainder, fourteen quarter-sheets and one whole sheet have been surveyed, and some of them are being engraved, while seventeen quarter-sheets and one whole sheet are in progress of being surveyed. There remain but twenty-four whole sheets and eighteen quarter-sheets at present untouched.

In the six northern counties of England, and also in Scotland, many maps of the coal-fields have been published on the scale of six inches to one mile.

Scotland is divided into 120 sheets on the one-inch scale. Of these, seven whole sheets have been published, two others, already surveyed, are being engraved, while portions of fifteen more have been surveyed or are in progress.

Ireland contains 205 sheets. 122 of these have been published, seven are prepared and engraving, and thirteen are in progress. There remain but sixty-three untouched.

In regard to the Museum, the Naturalist, Professor Huxley, reports that during the year 1,771 specimens were added to the collection of fossils. Among the purchases, he particularly mentions the sponges from the Upper Chalk, which were described and figured by the late Mr. Toulmin Smith, and the large collection of fossils, illustrating the palæontology of Northamptonshire and Rutlandshire, from the collection of the late Dr. Porter.

The Palæontologist, Mr. R. Etheridge, reports that 7,187 specimens, illustrating most of the formations, have been carefully examined and determined during the year.

In the Mining Record Office, many new plans and sections have been obtained, much information has been furnished to the public, and every effort has been made by Mr. Robert Hunt, the keeper of Mining Records, and his assistants, to produce the mineral statistics in the most reliable condition.

Dr. Frankland reports that the Chemical Laboratory has been *overcrowded* with earnest and attentive students, their number has during the year exceeded that recorded in any previous one, and the limited accommodation has necessitated refusal of admission to many. In the Metallurgical Laboratory, under Dr. Percy, there has likewise been a marked increase in the number of students over that of the previous year.

III.—The Natural History of Commerce; with a Copious List of Commercial Terms, etc.

By John Yeats, LL.D., F.G.S., F.R.G.S., etc.; assisted by several scientific gentlemen. London: Cassell, Petter, & Galpin, 1870. 8vo. pp. 436.

SIGNS are not wanting, in the publications of the day, of the near approach of a new era in National Education, which not only promises to promote a great advance in all branches of secular instruction hitherto in vogue, but even encourages us to hope that the Natural Sciences will be admitted to form a part of the curriculum both of our public and private schools.

Nor can anything tend more effectually to promote this much-desired object than the publication of such books as the present volume, in which is set forth the advantages to be derived by the mercantile community from a general knowledge of the elements and fundamental principles of Natural Science, when applied even to the ordinary concerns of trade and everyday life.

Dr. Yeats shows that a merchant may be a more able and a more successful merchant if he is acquainted with the Natural History of the Raw Materials of Commerce in which he deals.

He ought before he enters the Counting-house or the Manufactory to possess a general knowledge of the raw products of the various countries of our earth, whether animal, vegetable, or mineral, and the modes of their occurrence; nor will this suffice, for he should also be acquainted with the properties possessed by each, and the uses to which they are applicable. Strange as it may seem, this systematized knowledge of matter and its properties, long ago recognized as a part of the education of every youth in Germany and elsewhere on the Continent, has scarcely received any attention at all in this country.

Much that is contained in Dr. Yeats's book, although so full of interest to the general reader, is beyond the scope of this Magazine, but on turning to Chapter iii., entitled "The Effects of Geology on the Industry of the British People," we find at once the text for an ample and orthodox discourse.

To the fact that Great Britain presents in its rock-groups an epitome of the geological structure of Europe, if not of the known world itself, must be attributed a large share of the pre-eminence we enjoy as a nation.

Our insular position happily shuts us out from the danger of invasion by land, whilst our fleet securely guards our coasts from hostile navies; but we could offer, at the present day, but a poor resistance to the invader if we did not possess those two great essentials to national success, coal and iron. "Great Britain possesses a rich supply of minerals; we have gold, silver, copper, lead, tin, zinc, antimony, nickel, cobalt, bismuth, uranium, chromium, and other of the rare metals, besides vast stores of iron; our coal-beds are enormous; and earthy minerals are in great variety and value. Statistics show that in Great Britain 350,000 persons are actually engaged in mining operations, exclusive of quarries of all kinds, and that the produce is of the minimum value of £40,000,000." (p. 25.)

In illustration of England's mineral activity, take the one item of coal. We quote from p. 371, "The annual produce of the principal coal districts of the globe, according to the latest returns, may be stated as follows:—

	TONS.		TONS.
Britain	101,620,000	Spain	400,000
Zollverein (with lignite)	25,000,000	Sweden	230,000
United States	16,472,000	India	370,000
France	11,000,000	Australia	450,000
Belgium	4,000,000	China	100,000
Austria	2,270,000	Nova Scotia	651,300."

We see not only the effect of Geology upon our navies, turning our "hearts of oak" into "ironsides,"—trusting to coal and steam instead of canvas and Æolus to plough the deep,—but the presence of coal underground has decided the position of our staple manufactures, and we see Norwich, York, and Spitalfields compelled to resign the competition with Lancashire, owing to its situation with respect to our coal-fields. For the same reason the iron of the Weald of Kent and Sussex, so valuable, as long as wood was used as the fuel for smelting the ore, is now worthless, because richer beds have been found in the centre, the West and the North of England, in close proximity to Coal. Thus we see:—

> "The old order changeth, yielding place to new."

But in the foregoing enumeration we by no means exhaust the geological advantages of this island-home of ours. "Other bedded mineral products are met with in strata of various ages. Slates are quarried in Silurian rocks in Caernarvon and Merioneth, in Cumberland, and in some parts of Scotland. In these districts there is a very large population supported entirely by the quarrying and preparing of slates. Rock-salt is confined in Great Britain to the Keuper Sandstones and Marls. Building and architectural stones are chiefly quarried in the Devonian, Carboniferous, Permian, and Oolitic strata." (p. 31.) The coprolite-workings are also referred to, as an important branch of industry, and as furnishing the farmer with a rich source of phosphate of lime of organic origin, for manure, the remnants of faunas of Secondary and Tertiary age, for the utilization of which we are indebted to the Rev. Prof. Henslow, and which may be referred to specially, as an instance of the practical application of Geology to the benefit of agriculture.

The relation of Geology to Agriculture forms, of itself, a most interesting chapter of this book; it is a subject of the greatest national importance, and we are glad to know that the Government Geological Surveyors are also becoming convinced that the superficial deposits are deserving of their attention and mapping.

The present book contains: Part I. "The Natural History of the Raw Materials of Commerce."—Part II. "The Commercial Products of the Vegetable Kingdom."—Part III. "The Commercial Products of the Animal Kingdom."—Part IV. "Raw Mineral Produce;" and, lastly, an Appendix, containing a Vocabulary of the Names of Natural Productions, in the Principal European and Oriental Languages. The Geographical Distribution of Food and Industrial Plants is illustrated by a small coloured map, showing the Botanical Zones of the world.

Dr. Yeats announces that the present volume will be followed by "The Industrial and Political History" and by "The Technical History" of the same subject.

Among the list of contributors to the present volume we observe the name of Mr. Ralph Tate, F.G.S., F.L.S., a good guarantee for the careful execution of the geological part of the volume.

We heartily wish the author and his book all possible good, and trust that the future volumes may turn out as agreeable and readable as the present one.

CORRESPONDENCE.

AVANTURINE QUARTZ IN BRITAIN.

SIR,—In the GEOL. MAG. for Sept., p. 444, you announce that Mr. G. W. Traill has discovered "Avanturine Quartz" in Orkney, on the shores of Inganess Bay. It is spoken of as "a scarce *variety* of quartz," but it is really not a scarce mineral, nor is it a *variety* of quartz, but only ordinary quartz inclosing scales of mica. It is commonly met with in micaceous sandstones all over the world, and has no more right to a distinctive title than a quartz crystal containing any other foreign body entangled in its mass. B. J. R.

LONDON, *3rd Sept.*, 1870.

ARCHDEACON PRATT ON THE INTERNAL FLUIDITY OF THE EARTH.

SIR.—All Geologists must rejoice to see a question of such interest as that of the Internal Fluidity of the Earth discussed in the pages of the Magazine by authorities like M. Delaunay and Archdeacon Pratt. I confess that M. Delaunay's arguments, as given to us by Mr. David Forbes,[1] staggered my faith in Mr. Hopkins's method; although I saw that they did not establish the opposite to his conclusion, which was, that the solid crust of the earth cannot be much less than 1,000 miles thick.[1] Now, however, the Archdeacon comes to the rescue with the communication given in the September Magazine. What he proves appears to me to be this,—that if the crust of the earth is devoid of rigid connexion with the nucleus, and if a force acts upon it so as to give it a motion of rotation different from that which the nucleus already has, (in the case before us, the new rotation is given about a diameter of the equator, say that which momentarily coincides with the equinoctial line,) then the new rotation given to the crust will not *at first* be communicated to the nucleus. I say devoid of *rigid* connexion, for the effect of such connexion as arises from viscidity, or friction, or any similar cause, will simply be to communicate the new rotation to the nucleus less gradually than if the nucleus was absolutely fluid, and, therefore, the connexion *nil*. But in any case short of rigid connexion, the new rotation will not be communicated to the nucleus at all, *at first*. I mean at the moment at which it is communicated to the crust. Some time will be necessary for that result.

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[1] GEOLOGICAL MAGAZINE, vol. v., p. 511.

Now, the "precessional force," as the Archdeacon calls it, is "ever alive and active;" that is to say, we are obliged to consider at every moment its effect at that moment, or *at first*. And that effect is, to be producing at every moment a rotation in the crust, which will not have time to communicate itself to the nucleus before, by combining with the pre-existing rotation of the crust, it has caused the precession of the pole. The result will be that the amount of precession of the pole will be different in the case in which the nucleus is not rigidly connected with the crust, from what it would be if it were so. This is the conclusion that Archdeacon Pratt insists upon, and it seems certainly a just one. But, nevertheless, I cannot but think that the viscidity must have some effect upon the precession; and I should be very glad if your Correspondent would explain of what kind. What seems to me the case is this. The effect of the precessional force on the crust is to set it rotating about a generating line of the cone in which the axis moves, always a little in advance of the line round which the nucleus is rotating, and the viscidity will cause the axis of rotation of the crust to drag that of the nucleus after it. Will not this dragging effort have the effect of retarding the rotation of the crust in an extremely small degree, so that in the case of a viscid nucleus, the effect of the action of the sun and moon on the protuberant matter, as the equator is, in truth, indirectly to lessen the angular velocity of the earth, contrary to what is stated to be the case upon the usual supposition of the earth's rigidity?

If the rotation of the earth is diminished gradually, the precession will be increased accordingly. O. FISHER.

HARLTON, NEAR CAMBRIDGE.

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[1] See my paper on the elevation of mountains, &c. Cambridge Philosophical *Transactions*, vol. xi., part iii., p. 2. See also GEOL. MAG., 1868, Vol. V., p. 493.

ARCHDEACON PRATT ON M. DELAUNAY'S EXPERIMENTS ON THE INTERNAL FLUIDITY OF THE EARTH.

Sir,—In the Geological Magazine for September, you gave us a paper by Archdeacon Pratt, combating M. Delaunay's objection to Mr. Hopkins's method of reasoning from the precession of the equinoxes to the internal fluidity of the earth. There are some errors of inadvertence in that paper, which I do not point out, as no one is better able than the writer himself to discover them. We may agree, however, thus far with Archdeacon Pratt,—M. Delaunay's objection is not as conclusive as he himself seems to think. The *principle* of that object is indubitably true. M. Champagneur has proved it so by direct experiment; and it is (as appears to me) self-evident, *à priori*. If the tendency of the hard crust of the earth to shift on the internal fluid mass be sufficiently small, *relatively* to the degree of viscidity of the fluid, the crust must carry that viscous interior along with it in the changes of direction of its rotation. But *is* the relation such, in the case in question, as to make M. Delaunay's principle applicable? This question, I suppose, never can be answered. If the crust were even 1,000 miles thick, and if the fluidity of the interior were perfect, the pole of the crust would be slipping over the fluid interior at the rate of one inch in about twenty-five minutes (if the crust be as thin as some geologists have supposed, the rate of slipping would have to be nearly a third greater); and this shifting movement would occur all round the great circle parallel, at each moment, to that containing the celestial poles of the equator and the equinoctial points (taking the retrogressive movement of the earth's axis in its mean direction). Now, what amount of viscosity would be necessary to overcome the enormous moment of inertia, round its axis, of a globular mass 6,000 miles in diameter (or much more, as some would think), and start it afresh at every instant, in a new direction, at the above rate (or, greater), from a state of relative rest? And is the actual viscosity sufficient? Certain considerations would weigh for, and others against, M. Delaunay's opinion; but on which side of the scales the preponderance lies we cannot tell, from our ignorance of some of the conditions of the problem.

M. H. Close.

Newtown Park, Blackrock, Dublin,
October 4, 1870.

THE LECTURE ON VOLCANOS.

Sir,—Upon my return to London I received the Geological Magazine (for September), containing, page 440, a letter from Mr. Poulett Scrope, commenting upon my lecture on volcanos, which appeared in the July number; the following remarks in reply were, however, too late for last month's Magazine, as you informed me that the October number was then already in the press.

I have always looked upon Mr. Scrope's works on volcanos as being by far the best on the subject which we possess, whether they be considered from a philosophical or a descriptive point of view (and in the latter sense the author's experiences in the field render them doubly valuable), and, consequently, I had great pleasure, when perusing his letter, to find that he felt inclined to differ from me only in a very few, and I might add, not very important, points.

Having devoted some time to experimental researches upon volcanic action, and having had more than ordinarily good opportunities of studying in the field the active as well as passive volcanos of various parts of Europe, Africa, America, and Australasia, I attempted, in the lecture alluded to, a résumé of the conclusions I had arrived at independently, but which in many points fully confirm some long previously announced by Mr. Scrope himself; and had it not been for the necessity I was under, of condensing so large a subject as volcanos into the short space of an hour's lecture to a non-scientific audience, and, consequently, compelled to omit all explanatory details, I believe that Mr. Scrope himself would not have felt inclined to differ, even as to the few points to which he refers in his letter, and to which I will now briefly allude.

1. With regard to the formation of volcanic sands, ashes, and dust, I fully admit, with Mr. Scrope, that the greater part is probably due to the attrition of the particles *inter se* during their repeated ascents from, and descents into, the crater; nevertheless, microscopical examination shows that, in a very large quantity, the particles are more or less fused or rounded externally, as well as full of air, gas, or steam pores or bubbles, which would indicate that they have been comminuted and, as it were, blown to pieces whilst in the viscid, if not molten, state.

2. The opinion that molten lava, when suddenly brought into contact with water, is broken up instantaneously into coarser or finer particles, even to mud, is founded, not only upon observation, but on experiment also; for when it is found that molten lava, furnace slags, glass, and other silicates, do become so broken up when poured out suddenly into cold water, I think it is but reasonable and fair to infer that they would also so behave in nature, and, therefore, demur to the assertion, "It is very difficult, not to say impossible, to do more than guess at the effect produced on a body of lava expelled from a volcanic vent beneath water." The triturating action of the sea, which would naturally be enormously increased in such convulsions, is not only admitted but assumed by me as part of the process; the whole drift of the paragraph in question being to explain how great sedimentary deposits, composed of volcanic matter, may be formed, often similar in appearance, but infinitely more rapidly than those beds slowly built up from the débris arising from the wearing away of terrestrial rocks, brought down by the action of rain and rivers.

3. As before alluded to, this is but an instance in which my conclusions are identical with those previously arrived at by Mr. Scrope, and I feel sure that all unbiassed geologists must ultimately admit that the internal agencies have played the most prominent part in determining the external features of the earth.

4. Lastly, Mr. Scrope objects to the use of the words Cataclysm and Cataclysmic in contradistinction to Uniformity and Uniformitarian.

I am quite willing to extend the signification of Uniformitarian, in geology, to any action, however varied in intensity, from the most slow and steady to, at times, the most rapid or violent; as long as such catastrophes or paroxysms, as Mr. Scrope calls them, occur (like the striking of a clock) at regular or equidistant intervals of time, even if they do occur "but once in a century, or even in a thousand years." Before, however, internal or volcanic action can be brought under such a heading, it must first be proved that their catastrophes or paroxysms do occur at regular intervals; and until this is shown—more especially as the bulk of evidence at hand at present tends rather to the opposite conclusion—it does not appear unreasonable to continue to call these agencies Cataclysmic, as long as by the word Cataclysm in geology is understood some more than ordinarily violent event in the earth's physical history occurring at intervals altogether irregular and undeterminable.

David Forbes.

11, York Place, Portman Square, London, W.

A FACT RELATING TO THE CRAG PIT AT THORPE, NEAR NORWICH.

Sir,—In my paper on the Norwich Crag and associated beds, read before the Geological Society last autumn, I mentioned a local feature which I had noticed some fifteen years since, and which I had not seen reproduced since that period, viz., the occurrence over the shelly sand (Norwich Crag), overlying the Chalk, of a thin bed of clay (which I suggested might be the Chillesford clay), succeeded by an ironstone conglomerate containing impressions of shells. On my visit there again last week, I found in a freshly cut part of the section at the west end of the pit the same features exhibited, but on a larger and better scale. A bed about 2 feet thick, at the lower part of the gravel capping the section, is cemented into a ferruginous conglomerate, which has been the means of preserving the casts and impressions of numerous shells. Under this is a bed of light grey clay, 1½ foot thick, and then 5 or 6 feet of white sand and fine gravel, with an abundance of the usual Norwich Crag shells in the lower part of it.

The impressions in the ferruginous conglomerate are very abundant and very well preserved. My visit was too short to make a proper collection of them, and as the bed may, as the former one was, be worked out before long, I would direct the attention of any geologists visiting the pit to the interest of making a good collection of these fossils, amongst which I noticed the following:—*Pectunculus glycimeris* (?), *Cardium edule* (?), *Mytilus*, probably two species, *Paludina lenta* (?), *Mactra*, *Mya*, etc. These are the beds which I placed in the horizon of what I have termed the Westleton shingle, and which in the neighbourhood of Southwold contain casts of Mytili and other shells in abundance, and reposes in all that area on the Chillesford clay.

Joseph Prestwich.

THE GLACIAL DEPOSITS OF THE VALLEY OF THE AMAZONS.

SIR,—I have been much interested in the various articles on the subject of Glaciers published in the Magazine, and all the more interested as I find the statements supported by facts. I take the liberty of sending you a notice of some discoveries recently made, which bear particularly upon the origin of the great clay formation spread over the Valley of the Amazon. It is well known that Professor Agassiz, both before and after his visit to Brazil, considered it "Drift," the accumulation of detritus brought down from the Andes by glaciers. His theory rests mainly on the supposed absence of fossils, neither he nor your countryman Mr. Bates finding any. But in my late expedition across the continent I discovered a fossiliferous deposit at Pab~~o~~s, and since then my valued correspondent, Mr. Hauxwell, at my suggestion, has explored in other places on the Amazon, and found them in abundance near Cochaquinas, on the south side of the ~~Morsica~~. The shells are all found in the coloured plastic clays, which stretch, unbroken, from the foot of the Andes to the Atlantic. I have placed these interesting fossils in the hands of our eminent palæontologist, T. A. Conrad, Esq., of Philadelphia, for determination, and the result is as follows: 17 species, all extinct; 9 genera, six extinct.[1] The forms are all very singular and unique, and from their extermination, especially of one genus, with all its representatives, we infer that the formation cannot be late Tertiary, and may be Miocene. The species indicate fresh or brackish water life; and the perfect preservation of the most delicate parts, some specimens retaining even the epidermis, shows a quiet lake or estuary. There certainly are no indications of a "grinding glacier."—I am, yours, etc., JAMES ORTON.

VASSAR COLLEGE, POUGHKEEPSIE, NEW YORK,
October 7, 1870.

MISCELLANEOUS.

PETROLEUM.—In the Records of the Geological Survey of India, there appears a notice by Mr. A. B. Wynne, F.G.S., of the occurrence of Petroleum, (near the village of Sûdkal), near Futtijung, west of Rawul Pindi, in the Punjab. As usual in the Punjab, the Petroleum at this place occurs in the Nummulitic Tertiary rocks, which consist mainly of grey grits and sandstones, with some bands of grey fossiliferous limestone, interstratified with thick zones of red shale. The Petroleum pits are bounded by rocky ridges of slight elevation, on both sides of which the Tertiary rocks are much contorted along narrow axes, possessing considerable regularity of strike, and dipping at high angles. Fossils occur close by the Petroleum pits, as well as to the north and south of them. Orbitolites are by far the most numerous, but fragments of bivalve shells are also to be found, together with teeth of sharks and large bones. It is understood that the mineral oil produced from this locality is to be used for lighting the Station of Rawul Pindi with gas.—H. W. B.

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[1] The living genera are *Hemisinus*, *Bulimus*, and *Neritina*.

THE

GEOLOGICAL MAGAZINE.

No. LXXVIII.—DECEMBER, 1870.

ORIGINAL ARTICLES.

I.—Notes on Earthquakes.

Communicated by the President of the Geological Society of London.

Sir,—I beg to send you a notice, seemingly made with much care, respecting the origin and occurrences of earthquakes in England, which I find among some MSS. of an ancestor of mine, who, towards the end of last century, was an active Fellow of the Society of Antiquaries. It is curious as a record of the crude notions on volcanic phenomena prevalent to so near our times, and may be of some interest as a list—albeit imperfect—of the numerous earthquakes noted in a country where earthquake-movements are exceptional occurrences, and as a record of some peculiar phenomena which, notwithstanding the quaint and pretentious narration, have considerable geological interest. According to this record, the earthquakes were distributed as under by centuries and seasons.

		January	2.		
11th Century,	6.	February......	3.		
12th „	16.	March	2.		
13th „	6.	April	4.	Winter months .	11.
14th „	3.	May............	5.		
15th „	1.	June............	0.	Spring	11.
16th „	5.	July	3.		
17th „	9.	August.........	4.	Summer	7.
18th „	13.	September ...	6.		
	—	October	1.	Autumn	8.
Total.....	59.	November ...	1.		
		December......	6.		

This shows a great prevalence of earthquakes in the 12th century, a gradual decrease in numbers to the 15th, and then a gradual increase to the 18th century. They seem also to have been more numerous in winter and spring than in summer and autumn. The months, however, in many cases are not recorded, and no doubt the general record is confined to the more important and noticeable catastrophes.

Joseph Prestwich,
President Geological Society of London.

OF EARTHQUAKES, BY ME, SIR JOHN PRESTWICH, BART.

Written apparently about the year 1798.

The efficient or natural causes of all Earthquakes may be reduced under four general heads, viz., *Efficient, Material, Formal,* and *Final.* The first proceeds from the heat of the sun, which, by its continued heat, and dry weather, cracks the earth in such manner that it gapeth for moisture, which falling in at night it greedily swalloweth or imbibeth all the sundry exhalations of heat and cold generated by virtue of the sun, etc., and these being further attracted by the internal pores of the earth and other concommitant matter, quickly causeth a fermentation, which being pent within the concavities of the earth, and not having proper vent to issue forth by reason of the vapors, grossness, unctuosity, and inflammability, which penetrating through the different intricacys, and combating with the minute and close compactedness of the different stratas that compose the body of the earth which involves them, and therein increasing, and being pent up, and not finding a passage out, it swells, and thus further impregnating the earth with a combustable which at length bursts forth and so violently shakes the earth as to cause a trembleing with a dreadful noise, which is sometimes attended with flames of fire and such internal convulsions and falling in of mountains and leveling of them, sinking of islands and other grounds as Helice and Buris: so likewise of the earth, which once was where now is only three deep pits at Oxenhall, in the county of Durham, commonly called Hell-kettles, in the 24th of Henry II., and which the Chronicle of *Tinmouth* witnesseth in these words, That A.D. 1179, upon Christmas-Day, at Oxenhall, in the out-fields of *Darlington*, in the Bishoprick of *Durham*, the earth rais'd itself up to a great height in the manner of a lofty tower, and remained all that day till the evening (as it were fix'd and unmoveable) in that posture; but then it sunk down with such a horrid noise that it terrified all the neighbors, and the earth suck'd it in, and made there a deep pit which continues to this day. So also have the effects of earthquakes been recorded as the conversion of plain fields into mountains, and the raising of mountains in the sea, as THIA, THERAGIA, DELOS, RHODES, etc. Thus in like manner have mountains, buildings, trees, etc., been translated from one place to another, not to mention the following, as that of a whole town in Lombardy, in the reign of Henry the First; that in the thirteenth of Queen Elizabeth, of a hill of twenty acres, with a great rock under it, at Kinaston, in Herefordshire; and that of another in Anno 1583, which removed a field of three acres at Blackmore in Dorsetshire. Other consequences have been as the driving away or cutting the neck of some Isthmus from the Continent. For thus (saith Seneca) was Sicily divided from Calabria; Spain from Africa; and, if Verstegan say true, our Britain from France, not to mention those that have happened in our days at Lisbon, in Portugal, or those in Italy. Not to mention that which happened in Jamaica in the year 1692, which was owing to eruptions of fire that haveing consumed the bowels of the earth the ground sunk in, and the opening was so wide and dreadful that trees, houses, etc., were swallowed up; thus answering King David's account when he sayeth, "*The earth shook and trembled, the foundations also of the hills moved, and were shaken; because he was wroth.*" The continuance of earthquakes are uncertain, seeing that they are only in proportion to the greatness of their close vapour and firmness and solidity of the earth, that contain gross airs and sulphureous or bituminous matters, which uniteing in the manner of fermentation, and swelling with heat, immediately kindles, which being further assisted by the pent-up air, which being now in a violent motion, cannot rarefie and desperse, but encreasing take fire all at once, and bursting forth with a sudden concussion which make all the ground above to tremble and be convulsed, so as to cause an earthquake attended with a great noise like thunder, and frequently an erruption of water, smoke, fire, wind, etc., also the dividing or falling in of the earth as is before observed, by which means frequently whole cities have been swallowed up and destroyed.

Earthquakes that have happened in England, as recorded in our Antient Historians.

A.D.

974. A very great earthquake throughout England. *Sim. Dunelm. Hist.* col. 159.

1048. May 1. A very great earthquake in Worcestershire, Warwickshire, Derby, and many other places. A great mortality among the cattle, *et ignis aerius, vulgo dictus silvaticus, in Derbegensi provincia, et quibusdam aliis provinciis, villas et segetes multas ustulavit.* *S. Dunelm.* col. 183. *J. Brompton*, col. 939.

1067. *Terræmotus ingens totam Angliam exterruit*, 3° *Idus Aug. horrendo miraculo ut aedificia omnia eminus resilirent, et mox pristino more residerent* *W. Malmsb.* p. 125. *ed. Francf.*

1076. March 27. A general earthquake in England; and a frost from November 1 to the middle of April. *M. Westm.* p. 227, *ed.* 1601.

1081. April 25. One—*cum graviterræ gemitu.* *M. Paris*, p. II. *ed.* 1640.

1089. August 11. About three o'clock a very great one all over England. *Chron. Saxon*, and *Sim. Dunelm. Hist.* col. 215.

1090. One throughout all England, followed by a great scarcity of fruit and a late harvest.

1110. A very great earthquake at Shrewsbury. *Ib.* col. 232. One, *ib.* Shropshire.

1116. One in December.

1117. December 11. At midnight, *terra mota est, et luna versa in sanguinem.* *M. Westm.* p. 229.

1119. September 29. An earthquake in many places in England, particularly in Gloucestershire and Worcestershire. *S. Dun.* col. 240, and *Chron. Saxon.*

1120. One in September.

1122. July 25. A great one over all Somersetshire, and in Gloucestershire. *Chr. Saxon.*

1129. A great one on St. Nicholas's day. *Ibid.*

1133. An earthquake in England, which threw down many houses; and fire burst out of the earth. *Holinsh.* p. 44.

1134. One on the 2d of August; just as King Henry was about to take ship, and sail for Normandy, there was a most terrible earthquake. During the earthquake, flames of fire burst out of certain riffs of the earth with great violence.

1142. December 25. One felt thrice at Lincoln, and about the northern parts. *S. Dun.* col. 268, and *Roger de Hoved.* p. 629.

1145. January 25. At midnight a great one. *Chron. Gerv.* col. 1398.

1158. One in many parts of England, and the river Thames dried up at London. *Chr. Gervas*, col. 1380.

1165. January 25. One in Ely, Norfolk, and Suffolk, which threw people down, and made the bells ring. *M. Paris*, p. 104.

1185. April 15. A great earthquake—*fere per totam Angliam, qualis ab initio mundi in terra illa non erat auditus; petræ enim scissæ sunt; domus lapideæ ceciderunt; ecclesia Lincolniensis Metropolitana scissa est à summo deorsum.* *R. de Hoveden*, p. 629.

1187. An universal one, great and horrible—*ita ut etiam in Anglia, ubi raro contigit, multa ædificia subverterentur.* *M. Paris*, p. 144.

1199. May 22. A great one in Somersetshire and Norfolk—*ita ut stantes prostrârit.* *R. de Diceto Ymaginines*, col. 709.

1233. One at Huntingdon and other places. *Holinshed*, p. 217.

1247. February 13. An earthquake, chiefly felt in the river Thames (London). *M. Paris*, p. 723.

1248. December 24. A dreadful one in Somersetshire. *Ib.*, p. 756.

1250. December 10. One at St. Albans and parts adjacent. *H.*, p. 803, and *Holinsh.* p. 243.

1274. One in England. *Holinshed*, p. 277.

1275. September 11. One all over England, chiefly in the south and western parts, as Somersetshire, etc., which threw down St. Michael's Church on the Hill (now called the Tor), at Glastonbury. *Henr. de Knyghton*, col. 2461; *Trivet An.* p. 247; *Holinsh.* p. 278.

1328. November 14. The greatest earthquake ever known in England.

1380. May 21. An earthquake all over England, which much shook and shattered some of the buildings in Canterbury. *Chr. W. Thorn*, col. 2157.

1382. May. A general earthquake, very dreadful, with thunder and lightening, which did much mischief. The Friday following one less. The Saturday following one felt mostly by water. *Hen. de Knyghton*, col. 2644; *Holinsh.* p. 440.

1426. September 28. A very dreadful earthquake, with thunder and lightening.

1563. In September. One in divers places of the realm, especially in Lincolnshire and Northamptonshire. *Holinshed*, p. 1206.

1571. One in Herefordshire, which removed the earth. *Stow's Annual*, 40 Edit., p. 1131.

1575. February 26. Great earthquakes at York, Worcester, Gloucester, Bristol, Hereford, and counties adjoining. *Holinshed* describes it, p. 1260.

1580. April 6. A very great one in London, and almost generally throughout England. *Holinshed* describes it at p. 1311.

1580. May 1. One in Kent. *Holinsh.* p. 1313.

1657. July 8. One at Brickley Heath, in Cheshire (p. 395). Twenty yards of ground, with trees growing thereon, fell in 30 yards deep, and in place thereof nothing but water.

1665. One at Oxford, but attended with no ill effects.

1677. One at Wolverhampton in Co. Stafford, no ill effects.

1678. In Staffordshire and Derbyshire, no ill effects.

1680. In Somersetshire, no ill effects.

1683. At Oxford and in Lincolnshire, no ill effects.

1692. A great one in England, no great injury.

1693. September. An earthquake in England, France, and Germany, 100,000 perished by it in Sicily, and the chief town in Jamaica was destroyed.

1696. One at Falmouth, no ill effects.

1703. One in the North of England, no ill effects.

1727. In Cheshire and Wales, and almost all along the Western coast, as at Bristol, etc.

1732. In Argyleshire, Scotland, and all along the West coast of Great Britain, but to no great breadth; no ill effects.

1734. October 25. At Portsmouth, Milton, and most parts of Hampshire; also at Lewes in Sussex, and all along the coast for twenty miles; no ill effects.

1736. April 3 and May 1. At Ochill Hills in Scotland, no ill effects.

1739. December 30. In the West Riding of Yorkshire, no ill effects.

1747. July 1. At Taunton, and 40 miles round, no ill effects.

1749. In Scotland, no ill effects.

1750. One at London and the neighbouring parts—on February 8, and another very violent one on March 8; also on the 18th of the same month, one at Portsmouth, Gosport, and the Isle of Wight; no very great injury.

1755. Note the great one at Lisbon, the remoter effects of which were felt in this kingdom, as in many other distant parts.

1767. One in the North of England.

1783. One at Oxford.

1786. August 11. One in Lancashire, extending from the North to the South as far as Manchester, where it was slightly perceived. August 11—felt in the Island in Winander Meer; no very bad effects.

II.—On the Age and Geological Position of the Blue Clay of the Western Counties.

By Miss Charlotte Eyton.

It is a well-known fact that the shell-bearing gravels of the Western counties repose in many localities immediately upon a bed of blue or grey clay. This bed has been described as it appears in Lancashire and Cheshire, by Mr. Binney[1]; and more recently by Professor Hull[2]; in North Wales by Mr. R. D. Darbishire[3]; near Rugby by Mr. Wilson[4]; and in numerous localities by Messrs. Taylor, H. F. Hall, D. Mackintosh, and other contributors to the Geological Magazine, in various papers, all testifying to the great extent and importance of this bed.

A line drawn from north-west to south-east, from the Menai Straits, passing through Shrewsbury and Coal-brook-dale, and a little to the south of Rugby, will give a probable approximation to the southern boundary of this clay. On the west it extends into the bed of the Irish Channel, but does not attain to any great thickness among the Welsh mountains, though in the neighbourhood of Llandudno Mr. Hall assigns to it the unusual depth of 150ft.[5]

It appears to arrive at its greatest importance in the level plain of North Shropshire, Cheshire, and Lancashire, where it varies from about 25ft. to 100ft. thick. In Shropshire and in the neighbourhood of Crewe it is a stiff pure clay, free from silt, and with but few included fragments, and, very rarely, shells. It has, in fact, all the character of a deep-sea deposit. On the east of the plain it thins out, leaving the shell-bearing gravels in the neighbourhood of the Wrekin, to repose immediately upon the rock or upon the intercalated beds of red sand and mud which occur at all levels, being derived from the Red Sandstone of the locality. The same is the case in Cheshire, where the blue clay is found in its fullest development round Crewe, but disappears beneath the sandy gravels which, on the west of Congleton Edge, and above Macclesfield, repose directly upon the grit. Isolated patches, however, occur at high levels further east. One of these is seen near Swithamley Park, the seat of — Brocklehurst, Esq.; and in the lower part of the Biddulph synclinal, east of Congleton Edge, there is a small bed of impure clay, the constituents of which seem to be chiefly blue clay largely mixed with sand of various colours derived from the local grits.

The most southern point at which I know this bed to occur in Shropshire is a clay-pit near Leaton, between four and five miles west of Shrewsbury. It is highly probable, however, that it forms the base of Strethill, Coal-brook-dale.

In sinking a well at the Old Woods clay-pit, about a mile from the former locality, a bed of fine gravel, containing round quartz pebbles, flints, and granite, was found under 25 feet of clay. The base of the bed has not yet been reached, and no shells have hitherto been found; but as it has only been newly opened, it is hoped that we may obtain some specimens differing from those found in the overlying gravels.

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[1] Papers read before the Manchester Geological Society, 1842.

[2] Glacial Phenomena of Western Lancashire and Cheshire.

[3] Memoirs of the Literary and Philosophic Society of Manchester, 1868.

[4] Report of the Rugby School Natural History Society, 1869.

[5] Geological Magazine, Nov. 1870.

Mr Wilson's description of the blue clay, near Rugby, tallies so well with that of the above bed, that there seems scarcely any difficulty in recognizing it for the same; and what is still more important, is the fact that in some of the localities which he describes there are chalk fragments contained in the clay, thus very nearly identifying it with the "purple clay with chalk" [1] of Mr. Searles Wood. He says: "Below the gravel, in sinking Mr. Darnell's well," (at Hill Morton) "was a stiff sandy soil, wet with streaks of white and red clay, then a stiff blue clay containing chalk pebbles, three or four feet, and finally blue clay containing nodules of Limestone." "At the slope of the hill, on the way towards Clifton, the London and North-Western Railway offers a magnificent section through this deposit" (clayey sand). "The cutting is not less than 60 feet in depth and three-quarters of a mile long, and exposes a re-formation of Lias clay containing scratched stones. I have put in the school collection well-striated blocks of Liassic Limestone and Chalk and some flints, and a curious group of serpulæ."

It is not my intention in this paper to enter into a minute description of the deposit under consideration, that having been frequently done in reference to separate localities. I rather wish, after attempting a definition of its boundaries, to bring forward some points regarding its relation to the superincumbent beds, and thus to the whole series of drift deposits, which may result in assigning to it and them a more definite and satisfactory position than they now occupy. The points submitted are—

That the blue clay of the Western counties, underlying the shell-bearing gravels, strikingly resembles, in most of its characteristics, the "purple clay without chalk" [2] of Mr. Searles Wood.

That it passes in the neighbourhood of Rugby into a similar bed containing chalk, just as the purple clay of Yorkshire does on approaching the Chalk district.

That in the Cheshire and Shropshire plain it is apparently the deposit of a deep and calm sea, whereas the superincumbent sands and gravels must have been thrown up in shallow and disturbed water.

That the isolated patches of clay occurring upon the hills, considerably to the east of the main bed, afford evidence of currents passing from east to west during the height of the submergence.

That there being no overlying clays of equal extent and thickness, and equally persistent and uniform in their characteristics, it follows that there has been no general submergence of equal depth since its deposition.

That, therefore, it must coincide very nearly, in point of time as well as in general appearance and character, with the "true or great Boulder-clay" of the Eastern counties deposited during the height of the latest general submergence, as shown by Messrs. Harmer and Searles Wood, in their paper read before the British Association at Norwich; and that consequently all the overlying marine beds belong to the period of emergence, or may be accounted for by minor and partial submergences.

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[1] GEOLOGICAL MAGAZINE, January, 1870.

[2] GEOLOGICAL MAGAZINE, January, 1870.

The term "Glacial," applied to these beds, is somewhat vague. The period of glaciation in the Northern and Midland counties must have extended into comparatively recent times when the land had for the most part risen above the retiring waters, for we find striated and travelled fragments in beds of much later date than that we have been considering. But if the term "Glacial" is to be restricted to those beds which were deposited during the progress of the great submergence, as distinguished from those which were formed after the emergence commenced, then the blue clay must be held to be the latest glacial bed, notwithstanding the evidences of ice-action which occur on a later horizon. It would be well to arrive at a definite conclusion on this point, as well as on the use of the term Boulder-clay, as it may be the source of some confusion, especially to the unlearned.

The accompanying table shows the position of the drift-beds in the Eastern and Western counties relatively to each other and to the period of the greatest general submergence; supposing the position assigned to the blue clay to be the true one, the rest necessarily follows.

TABLE SHOWING THE RELATIVE POSITION OF THE MARINE DRIFTS IN THE EASTERN AND WESTERN COUNTIES.

Eastern Counties.	*Western Counties.*
The Hessle clay and gravel lies somewhere near this horizon. Also the Kelsea Hill beds with *Cyrena fluminalis*, a species never found in the Western counties.	Esker or re-assorted drift.
	Red clay with travelled and striated fragments.
	Shell-bearing sands and gravels, containing none but living species in connexion with mammalian remains.
Period of the greatest submergence.	
Purple clay without chalk of Yorkshire, etc.	Blue clay without chalk, passing at Rugby into
Purple clay with chalk, or Great Boulder-clay of the Eastern counties.	Blue clay with chalk.
Middle Glacial sands and gravels, containing extinct species and genera. No mammals.	Gravels underlying the blue clay. The exact horizon is doubtful.
Lower Glacial beds.	

III.—On the Evidences of Recent Changes of Level in the Mediterranean Coast-Line.[1]

By George Maw, F.L.S., F.G.S., etc.

THERE is, perhaps, no question of greater interest in the whole range of physical geography than the circumstances that have determined the existence on the earth's surface of large and comparatively unbroken areas of land and water, involving as it does the debateable subject of marine and sub-aerial denudation, and the careful weighing of evidence on the just apportionment of these operations and of oscillations of level that have brought about the existing boundaries of sea and land.

No observer, who has given the subject the least consideration, can pass in review new scenes of coast-line without having his attention directed to the evidences bearing on it; and having recently visited the Mediterranean, I beg to submit some remarks on a few of the many indications of change of level which its coast presents.

These may be considered under the following heads:—

1st. The Coast Structure, and the form of the land on the sea-board.
2nd. The Inset Current from the Atlantic.
3rd. The Limestone Caverns and Submarine Springs on the Coast-Line.
4th. The Lagoons on the Coast.
5th. The Coast Deposits of Post-Tertiary Age.

EVIDENCES OF DEPRESSION.

1st. *Coast Structure.*—On entering the Straits of Gibraltar from the Atlantic a notable change takes place in the aspect of the coast. Cape St. Vincent, on the Atlantic coast, presents a bold line of cliffs to the sea, and bluff cliffs extend many miles towards the Straits; but as soon as these are passed a change of coast-form takes place, which must be noticeable to every observer. Cliffs on the sea-board become the exception, and the general line of the coast is merely a shelving under the sea of the general hill-and-valley-system of the land, the sea running up all the depressions, and the land elevations spreading out into the sea with scarcely any abrupt cliff-line of demarcation.[2] The uneven sea bottom of the Straits seems to be a continuation of the contour of the adjacent land, consisting of rolling alternations of hill and valley which must have received its conformation by sub-aerial agencies.

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[1] Read at the Liverpool Meeting of the British Association, 1870.

[2] It is true that both Gibraltar on its eastern face and Apes Hill on the African coast facing the north present cliff-like contours, but in neither case are these on the present sea-board: most of the Gibraltar escarpment is separated by an intervening deposit of sand, and is not washed by the sea, and the face of Apes Hill is set back from the sea by an intervening undercliff; and I am inclined to attribute to both escarpments an earlier origin than the existing coast-line of the Straits. The Gibraltar escarpment appears to be on a line of fault which is visible in the Limestone at the southern extremity of the peninsula near Europa Point.

Corsica, and the adjacent islands of Elba, Capriera, and Monte-Christo, are also remarkable for the absence of cliffs, and are wanting in those abrupt escarpments separating land and water which are so abundant on our own coasts. Their aspect is that of mountain tops rising out of the sea, suggesting to the eye the seaward prolongation of their sub-aerial contour of sloping hill-sides and river-cut valleys, as though the sea had not stood sufficiently long at its present level to excavate an escarpment. The deep intersecting bays that occur along the coast from Marseilles to the Reviera, suggest the same conclusion, the undulating land surface spreading down to the water's edge, and the deep bays running up the intervening valleys, which must have had an origin common with that of their landward prolongations.

One of the most noticeable of these inlets, is the Etang de Berre, skirted by the railway between Arles and Marseilles. It has a superficial area of about 90 square miles. It is entirely land-locked, shut in by high ground of Jurassic limestone, and connected with the sea by only a very narrow outlet. There is an absence of cliff structure on its border, to which the surrounding land slopes down in gentle undulations. The sea cannot have effected its excavation through the existing narrow channel, and its basin must be a valley of sub-aerial denudation, into which the salt water has recently entered from the Mediterranean on the subsidence of the land. It is altogether different in character from the Stagnos or salt-water lakes on the low coasts. The almost complete isolation of this curious sheet of water suggests an affinity with the salt lakes of Algeria and other parts bordering on the Mediterranean coast, including perhaps the Dead Sea; all of which, probably, owe their saline character to connexion at some time with the Mediterranean. The various heights at which they occur both above and below the sea-level, and the various degrees of concentration of saline ingredients, in relation to the surrounding areas of drainage, involve intricate questions bearing on the changes of level and relative antiquity of the movements, which it would be of the greatest interest to carefully work out.

2nd. *The Inset Current from the Atlantic*—Several theories have been offered in explanation of the causes inducing the current that sets in towards the Mediterranean through the Straits of Gibraltar. Receiving as it does the sub-aerial drainage of more than a third of Europe and a large area of Africa, the natural inference is, that its accumulation would pass outwards through the Straits, and it has been suggested that a deeper return current towards the Atlantic compensates for the influx on the surface.[1]

Another theory is, that evaporation reduces the water of the Mediterranean at a greater rate than the supply from river drainage. This, however, would only be tenable supposing the area of evaporation bore a larger proportion to the land area of supply than does the open ocean to its sources of accession from land drainage, which is not the case. The evidences of repeated recent changes of level in the Mediterranean basin seem to suggest a more satisfactory explanation, viz.: That the influx through the Straits may be due to a gradual depression of the bottom *now going on*. The area of the Mediterranean is so great compared with the width of the Straits, that an amount of submergence, too slight to be perceptible on the boundary of the area subject to it, might produce such a current as exists, through the connecting channel with the Atlantic.

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[1] Sir C. Lyell stated in the discussion that the existence of a reverse current at a greater depth had been disproved.

3rd. *Limestone Caverns and Submarine Springs on the Coast-line.*—To the east of Mentone the Oolitic Limestone is extensively honeycombed with cavernous channels, some of which are filled up with loamy earth; others are open; and some serve as channels for subterranean streams. These caverns, which without doubt had a subaerial origin, are now, in one place at least, prolonged to a considerable distance below the present sea-margin. At about a mile to the east of Mentone, just opposite the point where the limestone is seen to be perforated with caves and channels, a fresh-water spring bursts up to the surface with sufficient strength to produce in calm weather a little oasis in the salt water. This spring probably at one time debouched on and flowed over dry land, since which the coast must have been considerably submerged.

EVIDENCES OF UPHEAVAL.

4th. *Lagoons on the Coast.*—The brackish water lakes which extend from the Spanish frontier on the west to the delta of the Rhone, and also along the east coast of Corsica, present some features indicating an upheaval of the coast. They are entirely distinct in character from the Etang de Berre, the salt-water lake near Marseilles before referred to. They are bounded by narrow spits of low land running parallel with the general direction of the coast, and these, cutting off, as it were, the indentations of the higher ground, give to the coast on the map between Perpignan and Marseilles a more direct line than the higher ground actually follows. These indentations are occupied by low marshy ground of an average height of eight or ten feet above the sea-level, and the shallow lagoons are shut off from the sea by bar-like ridges of shingle, blown sand, and marshy meadows. There is little in the character of these flats on the French continental coast to distinguish them from the seaward extension of low ground seen at the mouths of many rivers, and which accumulate independently of oscillations of level; but the lagoons and flats on the east coast of Corsica of precisely similar character and height afford evidence of a rise of the coast of at least 25 feet since the neighbouring low ground was deposited.

The most northerly of these is the Stagno di Biguglia, 3½ miles south of Bastia. It is a long narrow pool of brackish water, several thousand acres in extent, on the sea-margin of a great level tract of velly marsh land, and shut off from the sea by a narrow tongue similar land.

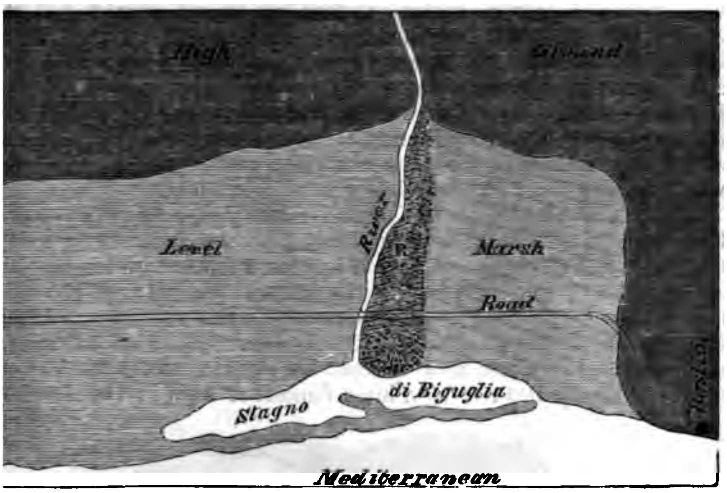

Fig. 1. Plan of the Stagno di Biguglia, near Bastia.

The main road from Bastia to Corte skirts for several miles this vel tract on the inner side of the Stagno, and follows, with one ception, a perfectly dead level. At about five miles south of astia, a sudden and abrupt rise takes place, and the road again escends to the general level of the marsh. The ridge (R), extend- g to the edge of the lagoon, can be traced inland up to the rising round of the older formations. At first sight the existence of this ng ridge of drift resting on the flat, evidently levelled by the sea, as difficult to account for; but on descending to its southern side, a

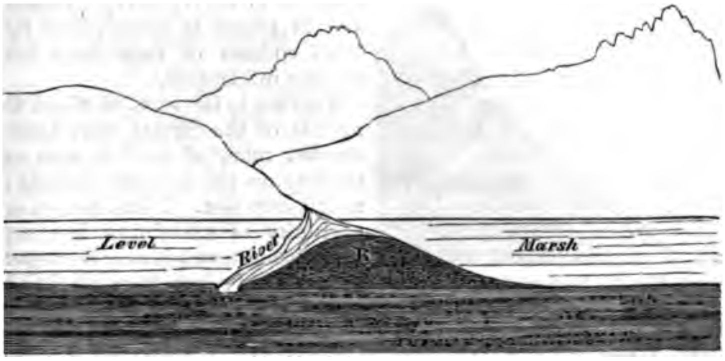

Fig. 2. Ideal Section of the Stagno di Biguglia, near Bastia.

nall stream running parallel with its course suggested an ex- anation. The long ridge of drift is evidently connected with the stream, as it leads up to where the stream leaves the hill-side on the edge of the plain, and evidently consists of matter it has deposited. The stream, however, under existing conditions, could not have maintained its course along the top of the ridge; but if we suppose the level marsh-land to have been at one time 20 or 25 feet lower, and covered by the sea, the accumulation resting upon it is accounted for, as the matter carried seaward by the stream at the point where it now enters the marsh on the hill-side; and on the rise of the land and the appearance of the delta-like ridge above the sea, the stream was naturally diverted to the lower level where it now flows.

5th. *The Coast Deposits of Post-Tertiary Age.*—As my observations on these beds have been limited to the neighbourhood of Gibraltar, I shall confine myself to noticing a few examples implying an elevation of the coast-line at the eastern extremity of the Mediterranean. One of the most remarkable is the great mass of sand flanking the eastern face of Gibraltar. As already noticed, most of the escarpment is not now washed by the sea, being covered to a height of nearly 700 feet by a huge deposit of sand in Catalan Bay.

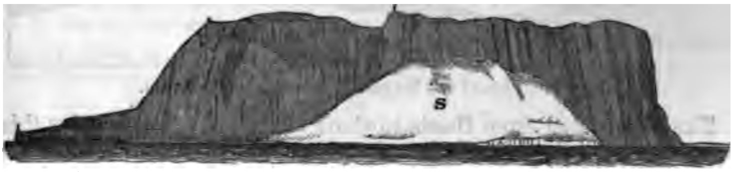

Fig. 3. Eastern Face of Gibraltar. S, Sand deposit of Catalan Bay.

It has been referred to by several geologists; and by some it has, I think, been incorrectly described as *blown* sand: it has somewhat the aspect of a sub-aerial talus, and from weathering and washing down, the beds of loose sand on its sloping surface range with its inclined contour; beneath this, however, it is found to be regularly stratified, and in places is consolidated into level courses of rock from Calcareous infiltration.[1]

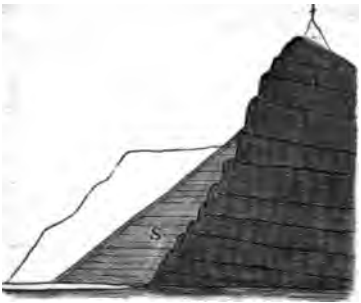

Fig. 4. Section of Gibraltar.
S, Sand deposit of Catalan Bay.

Further to the west, at about the middle of the Straits, near Tarifa, another mass of sand is seen extending up the land to a height of nearly 200 feet. I had not an opportunity of examining it except at a distance, and it may be merely blown sand; but from its height above the sea-level, I am inclined to attribute to it a similar origin to that of the stratified sands of Catalan Bay.

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[1] Mr. James Smith, of Jordan Hill, in his description of the geology of the rock (Quart. Journ. Geol. Soc., vol. ii., page 41), records the occurrence of *Patella ferruginea*, a recent Mediterranean species, at a height of 700 feet, and notices the evidences of old sea

Still further westward, outside the Straits in the neighbourhood of Cadiz, long ranges of low cliffs occur closely resembling the raised beaches of Devon, and, like them, composed of a hard concrete of sand and shells.[1] The shells are, I believe, of recent species. This raised beach would imply an elevation of the coast of 40 or 50 feet.

Crossing to the African side of the Straits, further evidence of recent upheaval is to be seen in level strata of sand and clay resting on the edges of nearly vertical strata of older rocks. At Tangier these occur at about 40 feet above the sea-level. They are probably of Post-Tertiary age (though I was unable to verify this by the detection of organic remains), and perhaps may be incidental to the same upheaval that elevated the raised beaches of Cadiz.

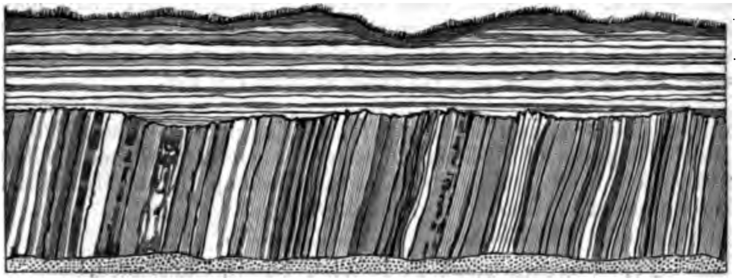

Fig. 5. Low Cliff. Tangier Bay.

General Observations.—These observations, which apply to only a very limited area of the great Mediterranean basin, are scarcely sufficient to place in proper sequence the various oscillations of level it has undergone, but may be brought into comparison with the abundant evidences of recent changes of level on the Mediterranean coast which have already been put on record.

The well-known case of the Temple of Serapis, recorded by Lyell, giving evidence of submergence and re-elevation within known heights and certain limitations of historic time, suggests a comparison with other evidences of similar elevation; and I would remark that Lyell's estimate of the amount of emergence of the shell-bored columns on the Italian coast agrees almost exactly with the amount of elevation in other distant parts, implied by the raised gravel ridge on the Corsican marshes, the great plain of shingle at the Rhone delta and the lagoons of the south-western Mediterranean French coast. Furthermore, Mr. Gwyn Jeffreys informs me that a recent marine deposit, containing *Galeomma Turtoni* and other shells of

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margins at various heights extending nearly to its summit. I cannot, however, admit that these recent oscillations of level can, as Mr. Smith supposes, be correlated with the various dislocations the limestone formation has undergone. On the upper part of the western face there is a general sloping sub-aerial contour which has superseded all surface evidences of structural dislocations, and both the denudation producing this western slope, and the occasional evidences of higher shore-lines superimposed on it, must have been infinitely more recent than the great dislocations of the limestone strata.

[1] It is sufficiently compact to be extensively quarried for building purposes. The city of Cadiz is almost exclusively built of it.

species now living in the adjacent parts of the Mediterranean, occurs at Antibes at a similar height, viz. 25 feet, above the sea-level; and Mr. James Smith, in the paper before referred to, attributes the sandy plain immediately to the north of Gibraltar to a period of stationary level with a littoral zone exactly 24 feet above the present level of the sea. The close coincidence in height is remarkable, and if these elevations at such distant points were contemporary, it implies a uniform amount of oscillation over a very large proportion of the Mediterranean area. The raised coast deposits at Tangier and Cadiz may have been connected with an independent oscillation of greater antiquity than the 25 feet rise, but yet more recent than that which submerged and re-elevated Gibraltar at least 700 feet.

The great basin appears to have been subject to repeated changes of level down to the historic period, and, judging from the distribution of deposits of such varied character close to the coast, the area subject to the oscillations must have been approximately limited to the present Mediterranean boundary.

IV.—CONTRIBUTIONS TO BRITISH FOSSIL CRUSTACEA.[1]

By HENRY WOODWARD, F.G.S., F.Z.S., etc.,
of the British Museum.

(PLATE XXIII.)

IN my fourth Report to the British Association,[2] I described, among other Crustacea, two species belonging to the genus *Cyclus*, one of which still remains unique. Since that date, I have, by the kindness of Professor T. Rupert Jones, F.G.S., received a number of specimens of this genus, collected by Prof. Harkness, F.R.S.; Mr. Joseph Wright, of Belfast; and Mr. J. H. Burrow, of Settle, Yorkshire; from the Carboniferous Limestone, which I now propose to describe.

1. *Cyclus bilobatus*, H. Woodw., sp. nov., Pl. XXIII., Fig. 3, 3a.

This specimen is from Settle, in Yorkshire, and was collected by Mr. J. H. Burrow. Its greatest length is three lines, its greatest breadth three lines. Viewed in profile, it is nearly hemispherical (see Fig. 3*a*), its greatest elevation being one line and a half. In general form it reminds us strongly of the dorsal aspect of certain Coleopterous Insects of the genus *Coccinella* or *Cassida;* the elytra being represented by the two large smooth posterior lobes of the shield, with their dividing ridge, and the head and thorax by the anterior third. The border is not flattened and curved outwards in this species, as in *C. radialis* and some others, but is bent downwards and terminates abruptly at the same angle as the rest of the carapace (see Fig. 3*a*). The frontal margin was probably divided into six parts, but it is only imperfectly preserved.

The anterior part of the carapace or buckler is divided transversely from the posterior and larger portion by, what, for convenience, we may call "the cervical furrow"; whilst a median, or "dorsal

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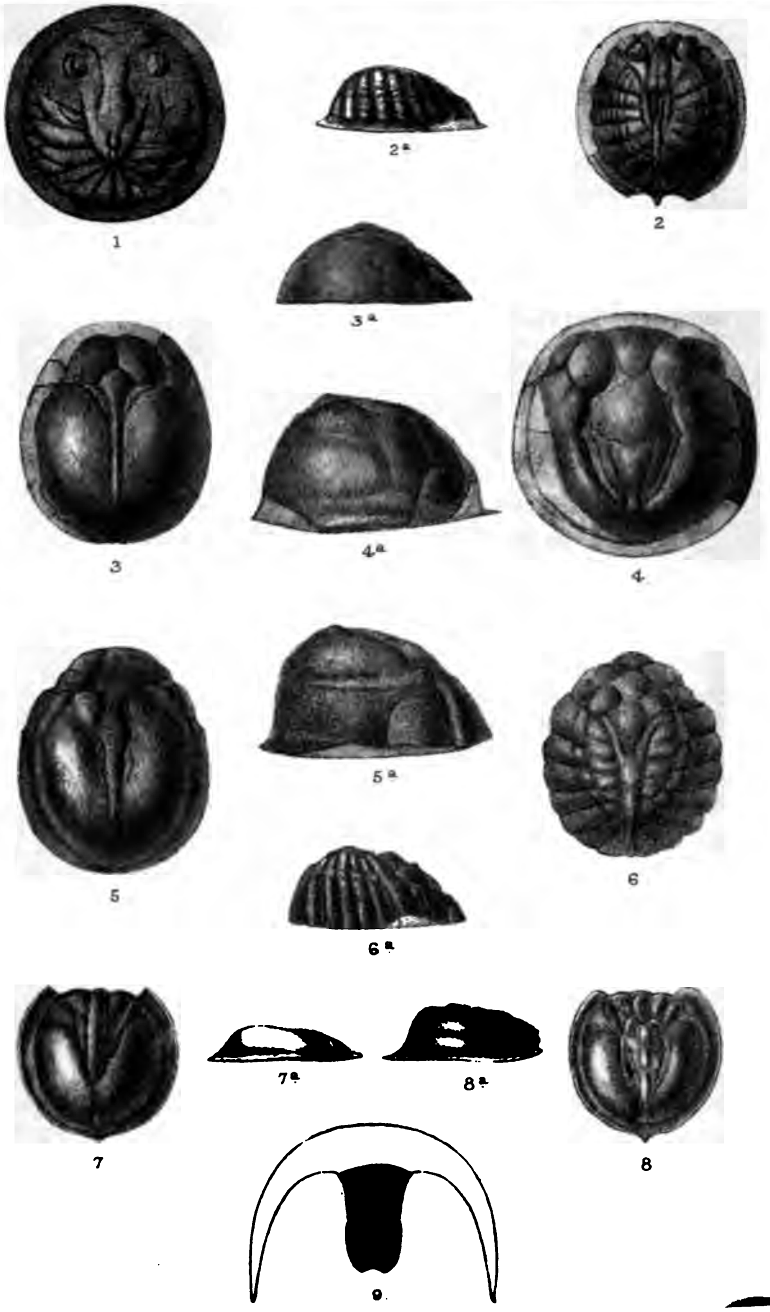
[1] *Continued from page* 497.

[2] 38th Report, Norwich Meeting, 1868, p. 72, Plate ii.



Hollick delᵗ et lith.

Crustaceans of the genus Cyclus from the British Carboniferous Rocks, &c.

furrow," divides it down the centre for about one-fourth of its entire length, thus separating the anterior parts into two equal lobes; here the median furrow diverges right and left in a crescent-shaped curve, and unites with the cervical furrow, leaving a small elevated median area (cardiac region?), which contracts rapidly backwards and is then prolonged as a narrow dorsal ridge—dividing the two 'elytra'-like lobes—to the posterior border. The anterior and expanded end of this dorsal ridge is ornamented on either side, at its union with the cervical furrow, by two small crescent-shaped lobes.

The surface of the carapace is everywhere smooth and devoid alike of tubercles and puncta.

2. *Cyclus torosus*, H. Woodw., sp. nov., Pl. XXIII., Fig. 4 and 4*a*.

The buckler of this species is nearly circular, and is four lines in diameter. Its dorsal line (viewed in profile) is very tumid, and is elevated two lines above its border (see Fig. 4*a*.). The cervical furrow divides the carapace—transversely—into two nearly equal parts (in this respect offering a marked contrast to *C. bilobatus*); the anterior moiety is divided into eight lobes, and the posterior into three. A narrow slightly flattened border appears to have nearly—if not quite—surrounded the shield.[1]

In front of the carapace is a median, somewhat triangular, lobe, having its rounded apex directed backwards; this is flanked on either side by two nearly round lobes, two placed subcentrally and two near each latero-anterior border. Uniting these five anterior lobes with the cervical furrow are two lateral five-angled lobes, and a central seven-angled (cardiac?) lobe or area. Behind the cervical furrow a dorsal ridge, of marked elevation, divides the posterior half of the carapace into two rounded lobes, which nearly unite behind—being only separated by a narrow dorsal ridge—but are widely separated in front, not only by the interposition of the dorsal ridge,—which expands like the head of a pillar before reaching the cervical furrow,—but also by the intercalation of two narrow lobes or ridges on either side of the expanded dorsal ridge. The even contour of the carapace is only markedly interrupted by a greater degree of prominence in the dorsal ridge just where it expands. The lobes are all roundly tumid, and, like the preceding species, almost smooth. *Cyclus torosus* was obtained from the Carboniferous Limestone of Little Island, Cork, by Mr. Joseph Wright.

3. *Cyclus Wrightii*, H. Woodw., sp. nov., Pl. XXIII., Fig. 5 and 5*a*.

This well-preserved form (which we have named in honour of the discoverer, Mr. Joseph Wright, of Belfast, who has devoted much time and attention to the investigation of the fossils of the Carboniferous Limestone of Ireland) was procured from the Limestone of Little Island, Cork.[2] It is oval in form, being 2¾ lines in length, two lines in breadth, and two lines in height. *Cyclus Wrightii*, like *C. bilobatus*, has a mimetic resemblance to a Coleopterous Insect, but the disproportion between the anterior and posterior divisions of the carapace is even greater than in *C. bilobatus*, the anterior part forming only one-fifth of the entire length. A narrow flattened border encircles four-fifths of the carapace, the anterior fifth apparently terminating abruptly at the margin without any border. The dorsal ridge is prominent and broad, and extends from the anterior to the posterior border, commencing as a narrow ridge behind. It spreads out into two successive rounded expansions, and again contracts somewhat before reaching the cervical furrow; in front of which it again becomes much wider, then contracting slowly towards the front. A somewhat triangular lobe flanks each side of this dorsal line in front, whilst two nearly round lobes are placed, one on either side of it, behind the cervical furrow. Nearer the latero-anterior margin, two other rounded lobes are formed, one on either side, by a branch of the cervical furrow.

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[1] Several of these forms may have been destitute of a rim in front. See *Halicyne*, Figs. 7 and 8.

[2] Another specimen, obtained by Professor Harkness from the Carboniferous Limestone of Keisley, near Appleby, Westmoreland, appears to be referable to this species, but the intractable nature of the matrix renders it impossible for me to work it out satisfactorily. See Prof. Harkness's paper, Quart. Journ. Geol. Soc., 1865, vol. xxi., p. 243, etc.

The two great latero-posterior lobes of the buckler have a single corrugated ridge, commencing very faintly at the posterior dorsal line, and running forward and curving around the sides of the carapace, and becoming more strongly marked near the cervical furrow.

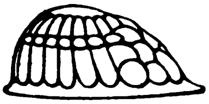
The surface is smooth or slightly and very finely granulated.

4. *Cyclus Harknessi*, H. Woodw., sp. nov., Pl. XXIII., Fig. 6 and 6*a*.

This elegant form approaches most nearly to *C. radialis*, but the border of the shield appears to be wanting. Its length is 3½ lines; breadth three lines; elevation two lines. Another specimen measured five lines in length; 3½ lines in breadth; and three lines in height.

In this species the usual cervical furrow, dividing the anterior from the posterior portion, is indicated by a ridge which commences in the middle of the shield where the raised dorsal line, instead of terminating, diverges into two lateral branches directed obliquely forwards, forming a Y-shaped elevation, from the branches of which the cervical furrow is continued down to the latero-anterior border.

From the margin of the dorsal ridge seven ribs take their rise, on either side, and descend the steep border of the buckler towards its rim, where, it is probable, they terminate in rounded extremities as in *Cyclus radialis* (Fig. 2 and 2*a*.), but the matrix conceals it (see Fig. 6*a*.). [I have, since the foregoing was written, been so fortunate as to detach a minute portion of matrix from one of the specimens, and have satisfied myself that such is really the case, so that Fig. 6*a*. needs to be added to along the basal line as in the accompanying woodcut.] These ribs are interrupted near the crown of the shield by two furrows, which encircle the posterior three-fourths of the buckler, so as to break up the ribs near the summit into two sets of tubercles, the inner and upper series being the larger, and the lower series the smaller; the surface of the ribs is finely granu-



Cyclus Harknessi, sp. nov.
(Side view, with margin restored.)

lated. In front, and partly inclosed by the Y-shaped cervical ridge, and forming the top of the anterior portion of the buckler, are four rounded lobes with polygonal borders, arranged in a diamond-shaped pattern, the posterior one (cardiac ?) being the largest of the four.

Placed around and forming a double border to these four lobes are eleven (?) others arranged, firstly, five in one row, and, secondly, (along the outer margin) six. (Surface of buckler finely granulated.)

The three specimens found, belonging to this species, are all from the Carboniferous Limestone of Little Island, Cork, from the collection of Mr. Joseph Wright, of Belfast.

5. *Cyclus radialis*, Phillips, sp., Pl. XXIII., Fig. 2 and 2*a*.

The subjoined description I copy from p. 72, Reports, 1868, British Association Report, Norwich Meeting.

"I was at first doubtful whether the *Cyclus radialis* of M. de Koninck, from Belgium, really represented the *Agnostus radialis* of Prof. Phillips, from the Carboniferous Limestone of Bolland, Yorkshire. I have fortunately been able to see and examine the original specimen of *Cyclus radialis* of M. de Koninck (and Gilbertson's specimens from Bolland, Yorkshire, preserved in the British Museum), and find that it does agree with the figure in Phillips's 'Geology of Yorkshire' (vol. ii. t. 22, fig. 25); but it entirely disagrees with M. de Koninck's *magnified* figure. I have, therefore, redrawn the Belgian form." (See Brit. Assoc. Rept. 1868, plate ii. fig. 1.) Mr. Hollick, in drawing *Cyclus radialis* for this present paper, was good enough to point out that the posterior border of one of M. de Koninck's specimens, from the Carboniferous Limestone of Visé, Belgium, drawn on our Plate XXIII., Fig. 2, was not broken (as I had supposed and figured it in my Report, see plate ii.), but was naturally indented upon the posterior border on each side, so as to leave a rudimentary spine at the termination of the dorsal ridge, as seen in our present figure.

"*Cyclus radialis* (Fig. 2) is an elegant shield-shaped carapace, five lines long by four lines in breadth; its general form is hemispherical, with a narrow smooth border (roundly indented behind, so as to leave a rudimentary medial spine in the centre); the shield is divided down its centre by a raised longitudinal (dorsal) ridge, from which radiate seven diverging ribs (transversely wrinkled), whose rounded extremities reach the lateral and posterior border.

"The anterior cephalic portion occupies about a quarter of the entire shield, and is ornamented by the spreading out of the raised central ridge, and by two sub-central rounded prominences which correspond in position to eyes, but are not facetted. The ribs are ornamented, each with from three to five tubercles, irregularly disposed over their surface."

This species (which is the first published species of the genus) occurs in the Carboniferous Limestone of Little Island, Cork; Bolland and Settle in Yorkshire; and Visé, Belgium.

6. *Cyclus Jonesianus*, H. Woodw., sp. nov. (Woodcut).

Whilst engaged in drawing up this paper, Mr. Joseph Wright has kindly sent me several additional specimens from Ireland, and, amongst them, one which is evidently a new form (see subjoined Woodcut).

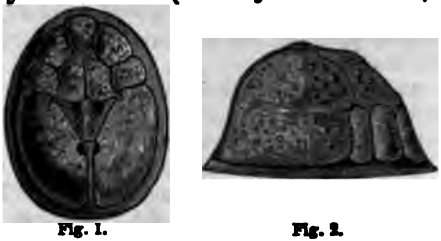


Fig. 1. Fig. 2.

Cyclus Jonesianus, sp. nov. (magnified four times).
Fig. 1. Dorsal aspect of Carapace.
Fig. 2. Side view of same.

The specimen, which measures three lines in length, two and a half in breadth, and two lines in height, was obtained from the Carboniferous Limestone of Little Island, Cork.

The carapace, which is finely granular all over, is divided, in front of the cervical furrow, into eight lobes, and behind the same furrow into two lobes, which latter occupy more than half the shield. The two posterior lobes are divided down the mesial line by the dorsal ridge, which at rather more than one-third the length stops short. Here two minute depressions occur, and the cervical furrow may be said to branch out right and left, inclosing a central triangular space (cardiac region?), having its base-line directed forwards and slightly crenated. In front of this triangular lobe two oblong lobes, united along the median line, occupy about one-fourth the length of the carapace (gastric region?), and are bordered by two pairs of lateral and one central, somewhat triangular lobe in front; the whole being probably surrounded by a narrow up-turned rim or border.

Cyclus Jonesianus rivals *C. Wrightii* in height, to which form and to *C. bilobatus*, it is, no doubt, closely related.

I have great pleasure in dedicating this species to my kind friend and fellow-labourer in palæontology, Professor T. Rupert Jones, F.G.S., of the Royal Military and Staff Colleges, Sandhurst, to whom I am indebted for much valuable assistance in understanding the hosts of the Bivalved Crustaceans (the *Ostracoda* and *Phyllopoda*), to the fossil forms of which he has devoted so many years of patient, ardent, and successful research.[1]

7. *Cyclus Rankini*, H. Woodward, Pl. XXIII., Fig. 1.

I first drew attention to this remarkable form at the Meeting of the British Association in 1868 (see Reports, p. 73). I extract the following account of it in order to complete this notice:—

"This new form of *Cyclus*, discovered by Dr. Rankine of Carluke, in the Carboniferous shales of that place, is most remarkable in appearance, and far more like a parasitical or larval form of Crustacean than the *Cyclus radialis*, which certainly possessed a hard calcareous test. A comparison of the two, however, leaves no doubt in my mind in referring them both to the same genus.

"The shield is about four lines in diameter, and conveys the idea of an extremely thin test flattened out on the soft shale by pressure. The 'eye-spots' occupy the same relative position as in *C. radialis*;

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[1] Professor T. Rupert Jones informs me that Mr. J. W. Kirkby has obtained evidence of a species of *Cyclus* in the Permian, but I have not been so fortunate as to see these remains, and must therefore defer their fuller notice until a future paper.

but the divisions which represent the costæ are six, not seven, in number in this species, and these anastomose together on the lateral border, and diverge, not from a raised median ridge, but from a broad V-shaped central area (cardiac region?). One is reminded by this Crustacean of the appearance of *Argulus*, *Bopyrus*, and other recent parasitic forms, and also of the disk-shaped *Discinocaris*, from which, however, it differs in the 'eye-spots' and costated shield.

"For this new species I propose the name of *Cyclus Rankini*, after its discoverer."

8. *Cyclus* (*Halicyne*) *laxus*, H. von Meyer, Pl. XXIII., Fig. 7 and 7*a*.

9. *Cyclus* (*Halicyne*) *agnotus*, H. von Meyer, Pl. XXIII., Fig. 8 and 8*a*.

Hermann von Meyer has figured in the Palæontographica, 1847, vol. i., p. 134, a small Crustacean head-shield under the name of *Halicyne agnota* and a second species under the name of *H. laxa*, from the Muschelkalk of Rottweil, in Germany. Goldfuss originally figured it as *Olenus serotinus;* afterwards Münster referred it to *Limulus* (Beiträge, 1841, Bd. i. t. v. f. 1).

To both these conclusions Von Meyer demurs—to *Limulus* because no eyes are visible; and to the *Trilobita*, because none are found in rocks older than the Carboniferous formation.

The form of this head-shield is extremely like that of *Agnostus;* but the *Agnostidæ* are confined to the Lower Silurian strata, between which and the Trias are the long intervening series of the Upper Silurian, the Devonian, Carboniferous and Permian formations. At the date of my report (1868), I was inclined to place *Halicyne* with *Bunodes*, *Hemiaspis*, etc., among the aberrant forms of the *Limulidæ*, being under the impression that it was only a part of a Crustacean, probably a head-shield. Having now the advantage of a large series of Carboniferous *Cycli* with which to compare it, I feel no longer any doubt about placing it with *Cyclus*, that being the older name.

"*Cyclus Brongniartianus*," De Koninck.[1] Pl. XXIII., Fig 9.

This species is founded upon the hypostome of a Trilobite, most probably of the genus *Phillipsia*. As several specimens have been forwarded to me so labelled, I take this opportunity to notice a mistake, which I feel sure M. de Koninck would (if the occasion had presented itself) have been one of the first to correct.

We quote the following remarks on *Cyclus* from the British Association Report already referred to (p. 73):—

"In describing *Cyclus radialis*, M. de Koninck observes:—

"There is no doubt this animal should be ranged with the Crustacea, and in Milne-Edwards's order *Trilobita abnormalia* and *battoidea*, near to *Agnostus*.

"M. de Koninck also thinks it probable that the body of *Cyclus* was soft and very contractile, that it was a parasite, and that the two tubercles which we have called the eyes really covered those organs; and, further, that the ribbed border protected the feet when the animal was in repose.

"We must differ from M. de Koninck in referring this form to the Trilobita. If truly an adult, it must be placed near to *Apus*, with-

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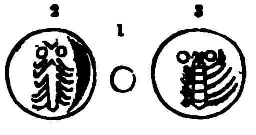
[1] Descrip. des Anim. Foss. Terr. Carbonif. de Belgique. Liége, 1842-4, p. 582. pl. lii., fig. 9, *a*, *b*.

the other shield-bearing Phyllopoda; if a larval form, it may have been the early stage of *Prestwichia* or some other of the Coal-measures *Limulidæ*. Nor do we think it in the least probable that the shield of *Cyclus radialis* was flexible or contractile, its original segments being completely soldered together into one piece."

Even amongst the **Decapod Crustaceans we may, in the larval and** embryonal stages, find **analogous forms to our fossil *Cyclus*. Thus Mr.** J. O. Westwood in the **Phil. Trans., Vol. I., Part II., 1835, figures from** Guilding's MSS., the **larva of a recent Land-crab having the appearance** presented in the subjoined **Woodcut.**



Figures of Larva of a Recent Land-Crab.
1. Nat. size. 2. Dorsal, 3. Ventral aspect.

The recent investigations of Dr. A. S. Packard, jun., and the Rev. S. Lockwood, tend further to confirm the opinion expressed by me in 1868, that these forms may indeed be the larval stages of *Prestwichia*, *Belinurus*, etc., the ante-types in Carboniferous times of the modern King-crab.

EXPLANATION OF PLATE XXIII.

Fig. 1.	*Cyclus Rankini*, H. Woodward, from the Carboniferous Shale of Carluke, Lanarkshire, from the cabinet of Dr. Rankine, Carluke. Enlarged 3 times. Dorsal aspect of carapace.
Fig. 2.	*Cyclus radialis*, Phil., sp., from the Carboniferous Limestone, Visé, Belgium. This species also occurs at Bolland and Settle, in Yorkshire; Little Island, Cork, etc. (Original specimen in the British Museum collection.)
Fig. 2*a*.	Side view of same. Both figures enlarged twice natural size.
Fig. 3. and 3*a*.	*Cyclus bilobatus*, H. Woodward, dorsal aspect and profile, from the Carboniferous Limestone of Settle, Yorkshire. Enlarged 4 times. (From the Cabinet of Mr. J. H. Burrow, Settle.)
Fig. 4. and 4*a*.	*Cyclus torosus*, H. Woodward, dorsal aspect and profile, Carboniferous Limestone, Little Island, Cork, Ireland. Enlarged 4 times. (From the Collection of Mr. Joseph Wright, Belfast.)
Fig. 5. and 5*a*.	*Cyclus Wrightii*, H. Woodward, dorsal aspect and profile, Carboniferous Limestone, Little Island, Cork. Enlarged 4 times. (Collection of Mr. Joseph Wright, Belfast.)
Fig. 6. and 6*a*.	*Cyclus Harknessi*, H. Woodward, dorsal aspect and profile, from the Carboniferous Limestone of Little Island, Cork, etc. Enlarged 4 times. (Collection of Mr. Joseph Wright, Belfast.)
Fig. 7. and 7*a*.	*Cyclus* (*Halicyne*) *laxus*, H. von Meyer, sp. Muschelkalk, Rottweil, Germany.
Fig. 8. and 8*a*.	*Cyclus* (*Halicyne*) *agnotus*, H. von Meyer, sp. Muschelkalk, Rottweil, Germany.
Fig. 9.	"*Cyclus Brongniartianus*," De Koninck. Hypostome of a Trilobite, probably of the genus *Phillipsia*, from the Carboniferous Limestone, Bolland, and Settle, Yorkshire; Blackrock, near Cork, and Visé, Belgium. (From the Collection of Mr. Joseph Wright, of Belfast.) Enlarged twice natural size.

V.—On Secondary Species of Brachiopoda.[1]

By J. F. Walker, M.A., F.G.S., etc.

I HAVE already described in this Magazine several new species of Brachiopoda from the Lower Greensand of Upware[1]; since then I have obtained many more specimens, and much kind assistance from

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[1] See Geol. Mag. 1868, vol. V., p. 399, Pl. XVIII. and XIX.

Mr. Davidson, and I now propose to give the result of the examination of the new forms in this paper; also to more fully describe a *Rhynchonella* from the Inferior Oolite of Lincolnshire, which I have named *Rhynchonella Crossii.*

Among the Upware specimens, the following new species and varieties have been met with:—

Terebratula Seeleyii, n. sp. Figs. 6, 7, and 8.—Shell elongated, ovate, moderately convex, shell surface smooth, marked by faint concentric lines of growth; ventral valve convex, curving regularly to the beak, which is very slightly recurved, and is truncated by a large round foramen; beak ridges slightly rounded, space between them and the deltidium flat; deltidium in one piece, large and moderately wide; dorsal valve elongated, moderately convex, the front margin not plicated, rounded; the shell becomes thin towards the front and lateral margins; greatest width about the middle of the shell. Loop short. Dimensions of the specimens figured: length 1·5 in., breadth 0·9 in., thickness 0·7 in.; and length 0·9 in., breadth 0·6 in., thickness 0·35 in. I have much pleasure in naming this fossil in compliment to H. G. Seeley, Esq., F.G.S. This species is well marked by its elongated form and absence of plications.

Terebratula depressa.—The specimens referred to this species vary so much from each other that it is necessary to distinguish the following sub-species, in addition to the sub-species *T. cyrta*, nobis.

Var. *T. uniplicata*, Figs. 1 and 2.—Shell somewhat triangular in form, with one wide mesial fold; shell surface smooth, marked by faint concentric lines of growth, greatest width about the middle of the shell; from thence it tapers to the beak, which is nearly straight, and is truncated by a large circular foramen; beak ridges rounded; deltidium wide, in one piece. At the front margin there is a wide central fold, formed by a depression of the ventral and a corresponding elevation of the dorsal valve. Loop short. Dimensions of the figured specimen; length 2·4 in., breadth 2·1 in., thickness 1·2 in.

Var. *Terebratula Cantabridgiensis*, Figs. 3, 4, and 5.—Shell moderately convex, surface smooth, marked by concentric lines of growth; beak slightly recurved, deltidium wide, in one piece; front margin of the ventral valve slightly elevated at the centre, then depressed, and again elevated; dorsal valve has two ridges which rise from near the centre of the valve, and terminate at the front margin, having between them a wide central depression. Loop short. Dimensions of the specimen figured: length 1·7 in., breadth 1·25 in., thickness 1·05 in. This form varies considerably with regard to the thickening of the front margin; some specimens have the front margin thinner and more rounded than the specimen figured, but retain the same form of plication, being reverse to the var. *T. uniplicata*, which has the central elevation on the dorsal valve and the depression on the ventral valve. *T. Cantabridgiensis* differs from *T. Dutempleana* in having the beak less recurved and the front margin more rounded. This variety approaches *T. prœlonga* in the plications, but differs from that species in its greater width, form of its beak, etc.

Terebratula Davidsoni.—I have obtained a very small specimen of

This species differs from *T. spinosa* in having the deep strongly marked fold formed by a depression of the larger, and the elevation of the smaller valve. The number of the plaits is fewer, and it does not appear to attain a larger size than the specimen figured. This species is common in the Inferior Oolite of Appleby, Brigg, Lincolnshire, but it is difficult to obtain perfect specimens. I have dedicated this species to the Rev. J. E. Cross, M.A., F.G.S., who gave me the specimen figured.

I have presented the specimens figured to illustrate this paper to the British Museum.

EXPLANATION OF FIGURES OF LOWER GREENSAND BRACHIOPODA FROM UPWARE.

Figs. 1 and 2.—Front and side view of *Terebratula depressa*, var. *uniplicata*.
Figs. 3 and 4.—Front and side view of ——— ——— var. *Cantabridgiensis*.
5.—Pallial border of same, showing the central elevation on the ventral valve.
Figs. 6 and 7.—Front and side view of *Terebratula Seeleyii*, sp. nov.
8.—Small example of same.
9.—Three views of *Rhynchonella Crossii*, sp. nov.

All the specimens are figured of the natural size.

VI.—ON THE DISPERSION OF CRIFFELL GRANITE AND CALDBECK PORPHYRY OVER THE PLAIN OF CUMBERLAND.[1]

By D. MACKINTOSH, F.G.S.

THE following is a very brief statement of the results of nearly two months' observations on the granitic and porphyritic drift of the north and north-west of Cumberland.

Derivation and Mode of Dispersion of the Granitic Drift.—From a little to the east of Workington, the south-eastern boundary of this drift crosses the river Derwent, and runs along between Great Broughton and Wyndham Row, north of Tallantire, by Parsonby, and Torpenhow, in the direction of Ireby; it then winds round the west and north slopes of Brocklebank ridge in a line running south of the Red Dial and Nether Welton. I have found the granite as far east as Wetherall, and believe it extends much farther, while on the north it approaches, if it does not cross, the Scottish Border. The boulders, most of which have been dug out of the fields,[2] occur principally in a sea-coast area reaching as far south as Workington, as far north as Allonby, and nearly as far east as Mealsgate; though, in thinly-scattered groups, and isolated blocks of smaller size, they may be seen farther to the north and east.[3] They rapidly increase in size and numbers towards the sea-coast, or in the direction of Criffell (on the opposite side of the Solway Firth), and gradually thin out inland until they can no longer be detected. There are comparatively few in the valley of the Ellen, even where other erratics are present. On the ridge to the north-west of this valley, and the part of the

ridge to the south-east which is situated near to the sea-coast, the boulders are the most numerous. They generally occupy positions in which they may have been left by grounding ice-floes. The granite is much the same throughout the whole area over which it has been dispersed. Where the large boulders are most numerous, at least five out of six are of a very coarse-grained light-coloured or grey granite, with crystals up to three-fourths of an inch in breadth and two inches in length. It often presents a more or less reddish tinge, when it looks somewhat like Shapfell granite, from which, however, it is structurally distinct. It is undoubtedly the same as the granite found *in situ* along the southern base of Criffell, and there it occurs in cliffs, as well as in block-strewn slopes, from which the boulders may readily have been launched. Next to the large-crystalled granite, a grey variety resembling the granite now quarried near Dalbeattie, on the north-west side of Criffell, is the most abundant. I have found it as far east as Nether Welton. Connected with this variety, and often graduating into it, there is a dark, streaked, or semi-gneissose granite. The above three varieties are characterized by dark blotches or patches, up to two or three feet in diameter, which in some instances look like fragments of whinstone caught up in the once-molten mass, in others like the effect of a process akin to segregation. These blotches are characteristic of the Dalbeattie and Criffell granite *in situ*, and are of themselves sufficient to indicate the derivation of the erratic blocks. The largest blocks of granite I have seen, which have evidently been transported from the Scottish side of the Solway Firth, are on the beach near Flimby. There are four near to one another, and each is about 8½ × 7 × 3 feet.

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[1] For Kirstone and Kirston, read Kirkstone, in my last article (GEOL. MAG. for Oct.).

[2] The so-called surface-blocks are those which have escaped being buried, or which have been disinterred by farmers. The boulders of granite and other rocks are found principally in the lower Boulder-clay, but they are not absent from the upper.

[3] Nearly all the boulders are more or less rounded.

In addition to the above varieties, there is a hard, reddish, coarse, syenitic granite, very abundant on the sea-coast among the smaller stones, and extending to the innermost boundaries of the granitic-drift area. I have not yet been able to trace its derivation. Mr. Mackenzie, of the Creetown Granite Works, near Wigtown, informs me that he has found it, in the shape of boulders, in his neighbourhood, along the sea-coast, and up the bed of the Cree, growing coarser and not so red near Cairnsmore. He has also found a small boulder of red, large-crystalled granite, in drift, at the Fell Granite Works. The Fell granite *in situ* is fine-grained and nearly white, with about one-eighth part of black mica. In the granite of Bagbie-bar quarry, about a mile farther south, and near the sea, about one-third part is black mica. Both these granites, I believe, are represented in the Cumberland drift, especially among the smaller stones and boulders.[1]

The principal facts above stated can, I think, be explained, in no other way than by supposing that the granitic boulders of Cumberland were derived from the opposite side of the Solway Firth. From

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This species differs from *T. spinosa* in having the deep strongly marked fold formed by a depression of the larger, and the elevation of the smaller valve. The number of the plaits is fewer, and it does not appear to attain a larger size than the specimen figured. This species is common in the Inferior Oolite of Appleby, Brigg, Lincolnshire, but it is difficult to obtain perfect specimens. I have dedicated this species to the Rev. J. E. Cross, M.A., F.G.S., who gave me the specimen figured.

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[3] Nearly all the boulders are more or less rounded.

In addition to the above varieties, there is a hard, reddish, coarse, syenitic granite, very abundant on the sea-coast among the smaller stones, and extending to the innermost boundaries of the granitic-drift area. I have not yet been able to trace its derivation. Mr. Mackenzie, of the Creetown Granite Works, near Wigtown, informs me that he has found it, in the shape of boulders, in his neighbourhood, along the sea-coast, and up the bed of the Cree, growing coarser and not so red near Cairnsmore. He has also found a small boulder of red, large-crystalled granite, in drift, at the Fell Granite Works. The Fell granite *in situ* is fine-grained and nearly white, with about one-eighth part of black mica. In the granite of Bagbie-bar quarry, about a mile farther south, and near the sea, about one-third part is black mica. Both these granites, I believe, are represented in the Cumberland drift, especially among the smaller stones and boulders.[1]

The principal facts above stated can, I think, be explained, in no other way than by supposing that the granitic boulders of Cumberland were derived from the opposite side of the Solway Firth. From

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[1] Accompanying the granitic drift, especially on the sea-coast, there are numerous pebbles, and occasional boulders of dark, hard, fine-grained whinstone, which would appear to have come from the Scottish side of the Solway Firth, where, in many places, it is the prevailing rock.

This species differs from *T. spinosa* in having the deep strongly marked fold formed by a depression of the larger, and the elevation of the smaller valve. The number of the plaits is fewer, and it does not appear to attain a larger size than the specimen figured. This species is common in the Inferior Oolite of Appleby, Brigg, Lincolnshire, but it is difficult to obtain perfect specimens. I have dedicated this species to the Rev. J. E. Cross, M.A., F.G.S., who gave me the specimen figured.

I have presented the specimens figured to illustrate this paper to the British Museum.

Explanation of Figures of Lower Greensand Brachiopoda from Upware.

Figs. 1 and 2.—Front and side view of *Terebratula depressa*, var. *uniplicata*.
Figs. 3 and 4.—Front and side view of ——— ——— var. *Cantabridgiensis*.
5.—Pallial border of same, showing the central elevation on the ventral valve.
Figs. 6 and 7.—Front and side view of *Terebratula Seeleyii*, sp. nov.
8.—Small example of same.
9.—Three views of *Rhynchonella Crossii*, sp. nov.

All the specimens are figured of the natural size.

VI.—On the Dispersion of Criffell Granite and Caldbeck Porphyry over the Plain of Cumberland.[1]

By D. Mackintosh, F.G.S.

The following is a very brief statement of the results of nearly two months' observations on the granitic and porphyritic drift of the north and north-west of Cumberland.

Derivation and Mode of Dispersion of the Granitic Drift.—From a little to the east of Workington, the south-eastern boundary of this drift crosses the river Derwent, and runs along between Great Broughton and Wyndham Row, north of Tallantire, by Parsonby, and Torpenhow, in the direction of Ireby; it then winds round the west and north slopes of Brocklebank ridge in a line running south of the Red Dial and Nether Welton. I have found the granite as far east as Wetherall, and believe it extends much farther, while on the north it approaches, if it does not cross, the Scottish Border. The boulders, most of which have been dug out of the fields,[2] occur principally in a sea-coast area reaching as far south as Workington, as far north as Allonby, and nearly as far east as Mealsgate; though, in thinly-scattered groups, and isolated blocks of smaller size, they may be seen farther to the north and east.[3] They rapidly increase in size and numbers towards the sea-coast, or in the direction of Criffell (on the opposite side of the Solway Firth), and gradually thin out inland until they can no longer be detected. There are comparatively few in the valley of the Ellen, even where other erratics are present. On the ridge to the north-west of this valley, and the part of the

ridge to the south-east which is situated near to the sea-coast, the boulders are the most numerous. They generally occupy positions in which they may have been left by grounding ice-floes. The granite is much the same throughout the whole area over which it has been dispersed. Where the large boulders are most numerous, at least five out of six are of a very coarse-grained light-coloured or grey granite, with crystals up to three-fourths of an inch in breadth and two inches in length. It often presents a more or less reddish tinge, when it looks somewhat like Shapfell granite, from which, however, it is structurally distinct. It is undoubtedly the same as the granite found *in situ* along the southern base of Criffell, and there it occurs in cliffs, as well as in block-strewn slopes, from which the boulders may readily have been launched. Next to the large-crystalled granite, a grey variety resembling the granite now quarried near Dalbeattie, on the north-west side of Criffell, is the most abundant. I have found it as far east as Nether Welton. Connected with this variety, and often graduating into it, there is a dark, streaked, or semi-gneissose granite. The above three varieties are characterized by dark blotches or patches, up to two or three feet in diameter, which in some instances look like fragments of whinstone caught up in the once-molten mass, in others like the effect of a process akin to segregation. These blotches are characteristic of the Dalbeattie and Criffell granite *in situ*, and are of themselves sufficient to indicate the derivation of the erratic blocks. The largest blocks of granite I have seen, which have evidently been transported from the Scottish side of the Solway Firth, are on the beach near Flimby. There are four near to one another, and each is about 8½ × 7 × 3 feet.

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[1] For Kirstone and Kirston, read Kirkstone, in my last article (Geol. Mag. for Oct.).

[2] The so-called surface-blocks are those which have escaped being buried, or which have been disinterred by farmers. The boulders of granite and other rocks are found principally in the lower Boulder-clay, but they are not absent from the upper.

[3] Nearly all the boulders are more or less rounded.

In addition to the above varieties, there is a hard, reddish, coarse, syenitic granite, very abundant on the sea-coast among the smaller stones, and extending to the innermost boundaries of the granitic-drift area. I have not yet been able to trace its derivation. Mr. Mackenzie, of the Creetown Granite Works, near Wigtown, informs me that he has found it, in the shape of boulders, in his neighbourhood, along the sea-coast, and up the bed of the Cree, growing coarser and not so red near Cairnsmore. He has also found a small boulder of red, large-crystalled granite, in drift, at the Fell Granite Works. The Fell granite *in situ* is fine-grained and nearly white, with about one-eighth part of black mica. In the granite of Bagbiebar quarry, about a mile farther south, and near the sea, about one-third part is black mica. Both these granites, I believe, are represented in the Cumberland drift, especially among the smaller stones and boulders.[1]

The principal facts above stated can, I think, be explained, in no other way than by supposing that the granitic boulders of Cumberland were derived from the opposite side of the Solway Firth. From

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Criffell, they must have radiated S., S.E., and E.[1] I have not yet ascertained if they were distributed in other directions. The greatest height at which I have found them is between 350 and 400 feet above the sea, at Parsonby and Nether Welton.[2]

Supposed Dispersion of Granite from Skiddaw.—The very limited exposures of granite in the Skiddaw area, and these chiefly at or near the bottoms of valleys or gills, would lead one to expect to find comparatively few indications of an exodus of granite from this area. The absence of granite from the district around Cockermouth (as I have had many opportunities of ascertaining), from the districts intervening between Cockermouth and Bassenthwaite, and between Bassenthwaite and the extreme south-east boundary of the granitic-drift area, shows that there has been no exodus of Syning Gill granite by way of Keswick and Bassenthwaite into north-west Cumberland; and I have not seen a bit of Syning Gill Granite in any part of the drift-area under consideration. The exodus of Skiddaw granite by way of Mosedale would likewise appear to have been very limited. I have not seen much granite to the north of Hesket New Market but what might have come from the Scottish coast. There is little or no granite strictly so called (so far as I could ascertain) in Caldbeck valley.

Dispersion of Porphyry, etc., from the Caldbeck and Carrock Fells.—From observations made since my last article was written, I have traced much of the North Cumberland drift to its source in these mountains. Felspathic trap, porphyry, and syenite have found their way S.E. and E.S.E. farther than the R. Eamont and Penrith; E. in the direction of Plumpton; N.E. and N. as far *at least* as the R. Eden; N.W. and W. as far as the sea-coast. Erratics from these hills have been carried across the Caldbeck valley and lodged on Brocklebank ridge up to a height of at least 950 feet above the sea. N., N.W., and W., they have become interwoven with the granite and whinstone drift from Scotland. In the neighbourhood of the Caldbeck Fells the most conspicuous erratic is what may be called tesselated porphyritic claystone. The porphyritic and granitic erratics are both a part of the boulder-clay deposits of the plain of Cumberland which extend from the mountains to the sea-coast. The lower boulder-clay preponderates, but upper boulder-clay may here and there be traced, especially towards the sea-coast. At Abbey Town, 50 feet above the sea-level, the upper boulder-clay contains numerous rounded and subangular stones, very much striated. As proved by well-sinkings, it is underlain by sand and gravel.

Interweaving of Drifts.—The above-mentioned, and other drifts, have not only been dispersed from centres in various directions in a manner quite inexplicable to me by glaciers or streams of land-ice (unless we feel justified in having recourse to a new order of causes and an entire change in physical conditions), but they have become mutually interwoven to an extent which, I believe, can only be accounted for by ice-laden currents, shifting their direction with the progress of subsidence, and drift-currents variously directed by changing winds.

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[1] Mr. Eccleston, of the Fawcett Schools, Carlisle, informs me that he has found boulders of Criffell granite as far east as Gillsland, and as far south as Whit beck, near Bootle. If I recollect rightly, there are numbers of them in the West-Midland counties.

[2] I have to thank the Messrs. Newall, of the Craig Nair (Dalbeattie) Granite Works, for corroborating my views, founded on Professor Sedgwick's theory, relative to the derivation of the Cumberland boulders.

The granite of the Criffell and Dalbeattie area, during its dispersion in directions between E. and S.S.E., has been crossed at various, including right-angles, by porphyritic and syenitic drift from the Caldbeck and Carrock Fells, over an area at least twelve miles in breadth.

Between S.E. and nearly S., Criffell granitic drift has been obliquely crossed, at various angles, by porphyry, trap, etc., from the Caldbeck hills, over the sea-coast area embraced by the granite, as far at least as Whitehaven.

Between S.E. and nearly S., Criffell granite, thinly dispersed over the southern part of the above sea-coast area, as far at least as St. Bees, has been extensively crossed, at right-angles and obliquely, by syenite and porphyry from Ennerdale and the neighbourhood.[1]

Porphyry, trap, etc., from the Caldbeck hills, in its south-western dispersion, has been crossed at various angles by syenite and porphyry from the mountains above Crummock and Buttermere waters, and the interior neighbourhood, over an area at least six miles in breadth; and the same syenitic and porphyritic drift has crossed the granitic drift (already crossed by Caldbeck drift) over an area attaining a breadth, on the sea-coast, of at least eight miles, from beyond Maryport to the neighbourhood of Harrington.

Quadripartite Division of Drifts in Cumberland.—The abruptness with which my last article in the GEOL. MAG. (Oct., 1870) concluded, may render a few additional notes on this subject necessary.—The drifts of Cumberland are more or less interwoven in *vertical* as well as horizontal succession. The upper red loamy clay (partly derived from the waste of the Permian strata), as already hinted, contains few boulders, but they are not altogether absent. I saw a large boulder of granite identical with that now quarried near Dalbeattie, in this clay, between Maryport and Flimby; and, a short distance to the N.W. of Carlisle, near the R. Eden, I saw two boulders of Dalbeattie granite (one of them 5 × 2 × 3 feet) in upper boulder-clay, in a railway cutting. Farther N.E., on the opposite bank of the river, a considerable thickness of the upper clay with boulders, may be seen resting on stratified gravel and sand—the latter resting on red sandstone rock. The sand and gravel formation of various parts of the plain of Cumberland (in the neighbourhood of Carlisle, Wetherall, Wigtown, Bullgill station,[2] Lamplugh, St. Bees, etc.,) contains pebbles and a few boulders of most, if not all, of the rocks found in the clay above and below. The finest section of sand and gravel, nearly horizontally stratified, I have yet seen in Cumberland, is near Harrington, where it composes a denuded knoll, and attains

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[1] I have lately found that limestone drift (including a split-block 10 feet in diameter and of unknown thickness) from the N. or W. has been left on the western slope of Dent Hill, near Cleator, by a current which, at a greater or less angle, must have been crossed by the above-mentioned syenitic and porphyritic drift from Ennerdale, which covers nearly the whole of Dent Hill (Skiddaw Slate) up to the summit, near to which, at 1,100 feet above the sea, there is a boulder, 8×8×5 feet, called amson's Cobble, or the Finger Stone, consisting of rock midway between porphyry and syenite.

[2] Here it forms a plateau, and rests partly on rock and partly on the reddish-brown clay.

a thickness of at least 50 feet. The reddish or yellowish-brown lower boulder-clay, which is often varied by a light bluish or greenish tint, contains the greatest number of large boulders. In many places, from Penrith to Workington, and elsewhere, it attains a great thickness. It has been mainly derived from the waste of the volcanic rocks and Coal-measure shales of Cumberland. The underlying bluish-grey clay rises to a height of at least 900 feet near Troutbeck railway station. It may be traced in the railway cutting not only between Troutbeck and Bassenthwaite lake, but between Cockermouth and Workington; between Marron Junction and Bridgefoot, where it is distinctly overlain by the reddish-brown clay; south of Branthwaite station, at Ullock station, where it is covered by a cargo of enormous boulders of sandstone, limestone, porphyry, etc.—the latter surmounted by red clay, sand, and gravel; and in other places. I have not seen any decided blue clay much farther north than the river Derwent. It would appear to have been chiefly derived from the waste of the Skiddaw Slates. There can be no doubt that in a great part of Cumberland, as well as in West Yorkshire (*see my paper on West Riding Drifts in the forthcoming Proceedings of the West Riding Geological Society*), there are four boulder drifts, two or three of which are often found in vertical succession, and the order of which is never found reversed. The extent to which these drifts have been removed by denudation, and the absence of sufficiently extensive sections, are probably the reasons why no very decided instance, so far as I am aware, has yet been discovered, in which all the four drifts are present.

In a few months I hope to be able to communicate an article, with a map, on the Drifts and Glaciated Rock-surfaces of the country between Whitehaven and Blackcombe, including the Eskdale granitic area.[1]

NOTICES OF MEMOIRS.

I.—On the Correlation of the Jurassic Rocks in the Department of the Côte-d'Or, France, with the Oolitic Formations in the Counties of Gloucester and Wilts, England.[2]

By Thomas Wright, M.D., F.R.S.E., F.G.S., etc.

THE department of the Côte-d'Or, which forms the northern portion of the Duchy of Burgundy, contains a very complete development of the Jurassic series. The region has naturally formed the subject of many important memoirs by French geologists, and no one has paid more attention to it than M. Jules Martin, who has carefully examined the palæontology of all the beds. His cabinet contains a large series of fossils from the different Jurassic stages, stratigraphically arranged, and including all the type specimens which he has figured and described in his works. Dr. Wright has had the opportunity of carefully examining this collection, and the result of this examination is here laid before the members of the Cotteswold Club.

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[1] In Professor Harkness' paper on Shapfell Blocks in the Quart. Journ. Geol. Soc. for November, it is stated that Shapfell granite does not occur in the Boulder-clay of the Eden valley, though Criffell granite is found in this clay. The Eden valley clay may have nearly ceased to accumulate before the high-level granite of Wasdale Crag began to be dispersed, and imbedded in the *pinel* or Boulder-clay of the mountains, in which it is associated with polished and striated stones and boulders. (*See article on Shapfell Boulders*, Geol. Mag., Aug., 1870.)

[2] Read at the Meeting of the Cotteswold Club, Aug. 31, 1869, and published in the Proceedings for 1869, pp. 143-237.

Dr. Wright publishes a valuable table, prepared by M. Martin, of all the stages of the Jurassic rocks exposed in the Côte-d'Or, wherein are pointed out their lithological characters, and the leading fossils contained in them. Having studied the beds in ascending order, he commences with—

1. THE RHÆTIC BEDS.—In the Côte-d'Or these beds are composed of sandstones and marls, with the characteristic *Pecten Valoniensis, Avicula contorta, Cardium Rhæticum, Lima præcursor,* and species of *Chemnitzia, Anatina, Myophoria,* etc. At Macigny they appear to be entirely arenaceous, with beds of arkose; the whole deposit rests on granite. The same lithological character prevails at Montigny, Semur, and Pouillenay. M. Martin has detected the bone-bed in several localities,—at Savigny, where it appears to occupy the upper part of the *Avicula-contorta* zone, at Memont, and at Remilly, where it is interesting to learn the complete transition, both lithological and palæontological, which obtains between the Lias and Rhætic strata. In the West of England, particularly where the white Lias is developed, the junction of these beds is generally well marked, and rather by a change of sedimentary condition than of unconformity. While nothing could be more gradual than the passage upwards of the New Red Marl (Keuper) into the grey marls of the Rhætic series.

A good number of species have been collected from the *Avicula-contorta* zone in the Côte-d'Or. Of reptiles, two species of *Termatosaurus*; of fish, 14 sp.; of Gasteropoda, 8 sp.; Conchifera, 46 sp., etc. Also one Echinoderm, one Coral, a Sponge, two Annelids, and a couple of Plants. The absence of Cephalopoda is marked, and but one species, *Belo-* (or *Geo-*?) *teuthis,* found by Mr. Boyd Dawkins in the grey marls at Watchet, has been recorded in this country. Dr. Wright gives some account, with sections, of the British Rhætic beds. They are well known from his previous publications, and the labours of Messrs. Charles Moore, Bristow, Etheridge, and others.

2. LIAS. — M. Martin divides the Lias into four stages:—1st. *Hettangien* or *Infra-Lias*; 2nd. *Sinémurien* or *Lias inférieur*; 3rd. *Liasien* or *Lias moyen*; 4th, *Toarcien* or *Lias supérieur*. The *Hettangien* is shown by Dr. Wright to represent the two lower stages of our Lower Lias—the zones of *Ammonites angulatus* and *A. planorbis.* The *Sinémurien* comprises two zones: *a.* Bluish marly limestone, with *Ammonites oxynotus, A. stellaris, A. Birchii,* etc. *b.* Marls and limestone, with *A. bisulcatus* (vel *Bucklandi*), *A. Scipionianus*, and

A. rotiformis. These are equivalent to the other Lower Lias zones, those of *A. Bucklandi*, *A. Turneri*, *A. obtusus*, *A. oxynotus*, and *A. raricostatus*.

The *Liasien*, which attains a considerable development at Semur, represents our Middle Lias, and the *Toarcien*, which attains nearly 500 feet, our Upper Lias. The "Upper Lias Sands" appear to be represented in the Côte-d'Or by ferruginous limestones and clays; they are included in the *Toarcien*. In the Cotteswolds, where they consist of sand and calcareous sandstones, and the distinction is sufficient to give a separate name to them, there is a diversity of opinion as to whether they are more closely related to the Upper Lias clay or to the Inferior Oolite. The probability seems that, in this respect, they occupy much the same position as the Rhætic beds, which belong as much to the Trias as to the Lias, and that similarly the sands form a passage between the Upper Lias clays and the limestones of the Inferior Oolite. The name should therefore be of a less particular kind, and have reference rather to any peculiar features of the beds themselves, or to the locality where they are best exhibited.

3. Inferior Oolite.—The *Oolithe Inférieure* (or *Etage Bajocien*) is well developed in the departments of the Côte-d'Or, Saone-et-Loire, and the Rhone, and it will bear, in many respects, the same divisions which this stage presents in the Cotteswold Hills. M. de Ferry has well described the Inferior Oolite of the neighbourhood of Mâcon, and Dr. Wright here reproduces a generalized section of the beds in the Jura Maconnais, in order to show how well the structure of our English Oolite is repeated in the centre of France. The Côte-d'Or presents a section essentially the same. It is divided by M. Martin into five stages.

4. Great Oolite Group.—In the Côte-d'Or, according to M. Martin, the *Bathonien* stage exhibits six palæontological zones, all perfectly distinct, and which represent, as Dr. Wright shows, the beds from the Fuller's Earth to the Cornbrash, inclusive. Dr. Wright gives a detailed description of the beds which occur in the West of England. The identification of this great Oolite group is essentially palæontological.

The Northampton sands, until lately considered to represent the Stonesfield slate (Great Oolite), are now referred, on palæontological grounds, to the Inferior Oolite. Between the Great Oolite and the Forest Marble there sometimes occurs a bed called the Bradford clay. Although considered as merely a local thickening of a Forest Marble-clay, Dr. Wright remarks that when this is wanting, it is almost impossible to distinguish the upper beds of the Great Oolite from those of the next formation.

5. Oxford Clay.—The Oxford clay, or *Oxfordien*, of the Côte-d'Or, is divided into five stages. The lowest, a very fossiliferous stage, represents the Kelloway rock. The other stages consist in the main of marls, in which the lower calcareous grit appears to be represented.

6. Coralline Oolite.—Ammonites, so useful in the other Jurassic formations, being rare in the Corallian strata, other leading fossils

have to be substituted in correlating distant beds. In France, Germany, and Switzerland, the beds admit of a triple division. The first, in descending order, characterized by numerous species of *Nerinæa* and *Diceras arietina*, is termed the "Nerinæan zone;" the second, remarkable for the large number of corals it contains, the "Coral zone;" and the third is called the "Echinidian zone," from the abundance of Echinoderms in it. Of these three zones the Coralline Oolite, Coral Rag, and Pisolite, of William Smith, may, in Dr. Wright's opinion, be correlated with the second and third zones just mentioned. The newest or Nerinæan zone is absent in England, and this forms a distinct group, according to M. Martin, to which he gives the name *Séquanien*, while he applies the term *Corallien* to the other beds just below it, and which lie above the *Oxfordien*.

7. Kimmeridge Clay.—The Upper Jurassic rocks were found by Dr. Wright to present a greater diversity of character in different regions than the members of the middle and lower divisions: the difficulty of establishing the synchronism of their several stages increases in the ascent from the Coral Rag to the summit of the Purbeck series. Our chief obstacle is considered by him to be the want of a better classification, and a more detailed study of the Kimmeridge Clay, and Portland formations of England. M. Martin divides his *Kimméridien* into—1. Marls and compact limestones with *Ostrea virgula*. 2. *Calcairesà Ptérocèren* with *Ostrea virgula* sparingly.

8. Portland Beds.—M. Martin makes two divisions of these beds, which are composed of marly limestones, the upper with *Trigonia Boloniensis* and *Pinna supra-jurensis*; the lower with *Ammonites gigas*. Dr. Wright points out the divisions made by other geologists. It is, however, in the environs of Boulogne-sur-Mer that perhaps the beds are best studied, and he therefore devotes some attention to the section given by M. Pellat. This he gives in a condensed form. The Portland beds are here divided into an Upper, Middle, and Lower, and comparing them with the section at Hartwell, he comes to these conclusions—1st. That in England the *Lower Portlandien*, or the beds with *Perna rugosa* and *Pterocera Oceani*, is absent. 2nd. That the *Middle Portlandien* is represented by the dark sandy clays of the brick-yard at Hartwell, containing *Ammonites biplex*, *Cardium Morinicum*, and *Ostrea expansa*, etc. A portion, likewise, of the overlying fossiliferous sand, with green Glauconitic grains, belongs to this group. 3rd. The *Upper Portlandien*, so largely developed in England, has at its base the non-fossiliferous sands without Glauconite, and in its middle and upper portions the true calcareo-siliceous limestones and other beds forming the Portland stone.

The correlation of our English strata with others at a distance is a subject of the highest interest, and although this sketch does little justice to Dr. Wright's elaborate paper, our object is gained by bringing it under the notice of the readers of the Geological Magazine.—H.B.W.

II.—On the Cause of the Motion of Glaciers.

By James Croll, of the Geological Survey of Scotland.

[Philosophical Magazine, September, 1870.]

THE ice of a glacier is now almost universally believed to be, not a soft plastic substance, but a substance hard, brittle, and unyielding. The power that the glacier has of accommodating itself to the inequalities of its bed, without losing its apparent continuity, is referred to the property of regelation possessed by ice. All this, says Mr. Croll is now plain; but what impels the glacier forward is still a question under discussion. The answer generally given is that gravitation alone is the force which does this. But as the ice of the glacier descends with a differential motion, we have not only to explain what causes the glacier to slide on its bed, but also what displaces the particles of the ice over and alongside one another. The Rev. Canon Moseley[1] has lately investigated the cause of the descent of glaciers, and he has found that the amount of work performed on a glacier during its descent through a given space is enormously greater than the work of the weight of the glacier descending through that space. He has determined that the aggregate work of the resistances which oppose themselves to its descent in a given time is about thirty-four times the work of the weight in the same time; consequently it is physically impossible that the mere weight alone of the glacier can be the cause of its descent.

He has further shown that the mere weight of the ice is wholly insufficient to overcome the cohesion of the crystalline particles, so as to break their connexion and cause them to be displaced one over the other. And this point Mr. Croll regards as fully established.

Mr. Croll reviews Canon Moseley's paper, and also the observations of Messrs. Mathews and Ball, published in reply to it.[2]

It is generally supposed that the ice-particles of a glacier are in a hard, solid, and crystalline state, and that, owing to differential motion, the cohesion of the ice-particles is broken, and that these solid particles are forced over and alongside one another. Two particles separate, and the one moves past the other. "But," asks Mr. Croll, "were the two particles, at the moment when separation took place, both in the hard, crystalline, and solid state?" Canon Moseley does not prove this; he merely assumes it to be the case, and shows that if the particles of the ice are in this state, weight is insufficient to produce the descent of glaciers, and, therefore, some force in addition to it is required to cause the phenomenon. Mr. Croll argues that Canon Moseley has not proved his point; he has only shown, that *if* the glacier shears in the way that it is generally supposed to do, it cannot descend by its weight alone. Canon Moseley regards solar heat as the primary cause of glacier motion. The fact that a glacier moves more rapidly during the day than during the night, and during summer than during winter, proves that there must be some physical connexion between the heat of the sun and the motion of the glacier. Mr. Croll could never harmonize this fact with the commonly-received theory; and, while admitting the agency of heat, he remarks that heat is not necessarily the *cause* of glacier-motion. Gravitation may be the *cause*, and heat only a necessary *condition*.

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[1] Proceedings of the Royal Society, January, 1869. See also Geological Magazine, May, 1870, p. 229.

[2] In reference to these replies, Mr. Croll states his inability to perceive that anything which they have advanced materially affects Canon Moseley's general conclusions as regards the commonly-received theory of glacier motion.

To him there seems to be but one explanation, namely, that the motion of the glacier is *molecular*. His concluding remarks are as follow: The ice descends molecule by molecule. The ice of a glacier is in the hard, crystalline state, but it does not descend in this state. Gravitation is a constantly acting force; if a particle of the ice lose its shearing-force, though but for the moment, it will descend by its weight alone. But a particle of the ice will lose its shearing-force for a moment if the particle loses its crystalline state for the moment. The passage of heat through ice, whether by conduction or by radiation, in all probability is a molecular process, that is, the form of energy termed heat is transmitted from molecule to molecule of the ice. But at the moment that it is in possession of the passing energy, is the molecule in the crystalline or icy state? If we assume that it is not, but that in becoming possessed of the energy it loses its crystalline form, and for the moment becomes water, all our difficulties regarding the cause of the motion of glaciers are removed. We know that the ice of a glacier, in the mass, cannot become possessed of energy in the form of heat without becoming fluid; may not the same thing hold true of the ice-particle?

Thickness of Glaciers.—Appended to his paper is a note by Mr. Croll on the alleged limit to the thickness of a glacier. Experiments by Canon Moseley, on the crushing of ice, led this gentleman to conclude, that if a glacier be over 710 feet in thickness, the ice at the under surface must be crushed by the incumbent weight. Experiments previously made by Professor Phillips had led him to the conclusion that a glacier, exceeding 1,500 feet in thickness, would lose its solidity.

Mr. Croll maintains that, as a necessary consequence of the property of regelation, ice, after being crushed, would resolidify. So far as he is aware, there is no known limit to the amount of pressure which ice may sustain. On the Antarctic continent we have reasons for believing that the ice is in some places over a mile in thickness.

REVIEWS.

I.—On the Fossil Cycadean Stems from the Secondary Rocks of Britain. By William Carruthers, F.L.S., F.G.S., British Museum. Transactions of the Linnean Society of London, Vol. xxvi., 1870, pp. 675–708. 4to. 10 plates.

OUR knowledge of the true classification of the remains of fossil plants has greatly increased of late; not that any very large additions have been made in the number of species described since the days of Lindley and Hutton, but we have become better acquainted with the real characters, not only of many already described, but of others subsequently discovered.

Among those who have specially devoted themselves in this country to this subject, we may cite the names of Hooker, King, Williamson, Binney, as well as of the author of the paper before us, whose name has now become familiar to the readers of this Magazine by his frequent contributions to its pages.[1]

Mr. Carruthers, like Dr. Hooker, has brought to bear upon fossil forms an extensive knowledge of recent plants, both structural and physiological, which gives to his published opinions considerable weight when treating of the relics of vegetable remains found imbedded in the various strata.

So frequently indeed do the remains of plants occur in a fragmentary state (from which fragments sometimes species, and even genera, have been made almost at random), and considering also how commonly the more important parts by which plants can be identified are wanting in the fossil state,—as, for instance, flowers and fruits,—or, if found, are frequently dissociated from each other; it requires all the skill and special knowledge, derived from the study of recent Botany, generally to allocate and rearrange the scattered fragments and determine their true affinities.

This method of investigation is thoroughly carried out in the Monograph before us, "On the Fossil Cycadean Stems from the Secondary Rocks of Britain."

The recent *Cycadeæ* are a peculiar and interesting group of Gymnospermatous plants which from their organs of fructification are related to Coniferæ, and in their habit of growth present somewhat the aspect of Palms. As a group, they are restricted to the Asiatic, to the African, to some part of the Australian, and to the American Continent.

The fossil remains of this family are chiefly confined to the Mesozoic strata, in which their remains are both abundant and characteristic, for their stems, leaves, and fruit are so perfectly preserved that their true nature can be determined with the utmost precision.

Most of the organisms in the Palæozoic rocks referred to this group are either difficult to determine, or belong to other plants. "The detached fruits present no characters justifying their reference to *Cycadeæ*. The stems from the Coal-measures, figured and described by Presl under the names of *Cycadites columnaris*, *C. involutus*, and *Zamites Cordai*, are certainly arborescent cryptogams belonging to the same group as *Lepidodendron*, as Brongniart and Miquel have already shown." (p. 675.)

Other Palæozoic genera which have been referred to Cycads also belong to the Cryptogams. Thus Mr. Carruthers observes:—"The structure of *Medullosa*, Cotta, and *Colpoxylon*, Brong., referred by Göppert, Miquel, and Unger, to *Cycadeæ*, differs so essentially from any known stem of that order, that I would even go further than

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[1] No fewer than sixteen papers by Mr. Carruthers on Fossil Botany (besides eight on other subjects) will be found in the pages of this Journal.

Brongniart, who considers their Cycadean claims to be very doubtful, and say that, as far as the evidence supplied by the stem goes, their affinities are much more with the vascular Cryptogams than with any tribe of Phanerogams." (p. 676.)

So far as our present knowledge extends, the *Cycadeæ* are remarkably absent from beds of Tertiary age. "The stem from the Paris basin," writes the author, "referred by Presl to this order, under the name *Zamites Brongniartii*, is, as Brongniart originally described it, an Endogen. The only other supposed indication of Tertiary *Cycadeæ* is the fragment of a leaf (*Zamites arcticus*) described by Göppert, from the Miocene beds at Kook, in Greenland." (p. 677.) He adds:—"It cannot be supposed that *Cycadeæ* were absent from the vegetation of the Tertiary period, their non-discovery hitherto must be taken as another instance of the imperfection of the record of extinct life with which students have to deal." (p. 677.)

A general bibliography is given of this class from the first notice of them by Mantell, in 1822, followed by Presl (1825), Brongniart (1828), Lindley and Hutton (1833), Sternberg (1838), Göppert (1844), and Oldham and Morris in 1862.

This is followed by a clear synopsis of the genera and species of the fossil stems hitherto discovered in Britain, and which includes six genera, and two others not hitherto recognized as British, namely *Crossozamia*, Pomel; and *Raumeria*, Göppert.

The genera are arranged under four tribes:—

Firstly, the CYCADEÆ: including the genus *Bucklandia*, Presl; and species, *B. anomala*, *B. Mantelli*, *B. squamosa*, *B. Milleriana*. The two first-named species being from the Wealden, and the two last-named from the Oolite.

Secondly, the ZAMIEÆ: including the genus *Yatesia*, Carr.; and species *Y. Morrisii*, Lower Cretaceous; *Y. gracilis*, Lias; *Y. crassa*, M. Oolite; *Y. Joassiana*, M. Oolite: the genus *Fittonia*, Carr., and species *F. squamata*, U. Cretaceous; the genus *Crossozamia*, Pomel, and species *C. Moreaui*, Pomel, Jurassic; and *C. Buvignieri*, Pomel, Jurassic; both from St. Michel, France.

Thirdly, the WILLIAMSONIEÆ: including the genus *Williamsonia*, Carr., and species *W. gigas*, *W. pecten*, *W. hastula*, all from the Inferior Oolite.

Fourthly, the BENNETTITEÆ: including the genus *Bennettites*, Carr., and species *B. Saxbyanus*, Wealden; *B. Gibsonianus*, Lr. Greensand; *B. maximus*, Wealden; *B. Portlandicus*, Lr. Purbeck; and *B. Peachianus*, M. Oolite: the genus *Mantellia*, Brong., and species *M. nidiformis*, *M. intermedia*, *M. microphylla*, from the Lr. Purbeck; and *M. inclusa*, from the Lower Cretaceous: the genus *Raumeria*, Göppert, and species *R. Reichenbachiana*, from Galicia, and *R. Schulziana*, from Silesia.

Mr. Carruthers gives a most careful and detailed description of the characters upon which each of the fossil genera are established.

Commencing with *Bucklandia*, Mr. Carruthers adduces reasons for considering it the same as *Clathraria*, of Brongniart, and as closely related to the living *Cycas*. The author observes (p. 683): "The stems were cylindrical, attaining a height of at least four feet, and sometimes dividing dichotomously. The stem exhibits a series of alternating swellings and constrictions, and is covered with more or less rhomboidal scars, arranged in close proximity to each other, and in a quincuncial manner," etc.

By a reference to the recent *Cycas circinalis*, Mr. Carruthers clearly explains the mode of growth in *Bucklandia*:—"The remarkable correspondence between the recent and the fossil stems, both belonging, as there can be no doubt, to the same order of plants, may fairly be inferred to have been produced by the same cause; that the large scars are the bases of true leaves; the smaller scars immediately succeeding them, as is established by their slight imbrication and the small cicatrix on their upper margin, supported lanceolate scales; and the somewhat larger sized scars on the upper portion of the constriction were produced by the bases of the fruit-bearing leaves." (p. 684.)

The genus *Yatesia* seems to be distinguished from *Bucklandia* by having no band of specialized fruit-bearing leaves borne on the main stem; and the leaf-scars are nearly equal in size throughout.

The new genus *Williamsonia* is probably among the most remarkable of the organisms herein described, and has been the subject of much curious and interesting speculation, from the time of Young and Bird (who compared the male inflorescence to that of the artichoke) to that of Mr. Yates and Prof. Williamson (in the Proceed. York. Phil. Soc.). The latter gentleman, who has had these fossils under his notice for thirty years, liberally offered to place his notes at Mr. Carruthers' disposal for this memoir, but he has been persuaded by the author to incorporate the numerous facts he had collected, and his ingenious interpretation of them, in a separate memoir under the title of *Zamia gigas*. From the peculiarities of the organs of fructification and other characters (for the elaborate exposition of which the reader is referred to Prof. Williamson's memoir), the genus *Williamsonia* has been established by Mr. Carruthers.

An elaborate and carefully prepared diagnosis introduces the genus *Bennettites* (Carruthers), named after his distinguished colleague, and based upon some well-preserved specimens obtained from the Wealden and Lower Greensand of the Isle of Wight, fragments of which had formerly been referred to *Bucklandia anomala*, by Mantell; it had also attracted the attention of the late Robert Brown, who observed that all the Isle of Wight Cycads agreed "in having an elliptical outline, unaccompanied by any inequality in the woody ellipsis, and also in having a bud in the axilla of each leaf," thus differing from all other Cycad stems which are circular in outline and have only scattered buds (p. 695). But the more complete examination of newer materials at his disposal have revealed structures in the organs of fructification, as well as in the stem, which justify their being placed, not only in a distinct genus, but as forming a well-marked group: one peculiarity being that the fruit is borne in a secondary axis not protruding beyond the basis of the petioles. Mr. Carruthers says (p. 698):—

"In comparing the structure of this plant with the inflorescence of the recent *Cycadeæ*, the points of difference are more obvious than those in which they agree. The most important correspondence is to be found in the structure of the seed, and its envelopes. The fossil is truly gymnospermous, the pollen having access to the embryo-sac through the tubular openings in the covering of the seed, and not through a style developed from an investing carpellary organ. The most remarkable difference is to be found in the compound fruit of the fossil. In the recent members of the order, the fruit, whether borne on slightly modified leaves, as in *Cycas*, or on the peltate or imbricated scales of a cone, as in the other genera, is always produced on foliar organs. In the fossil, on the other hand, it is borne at the end of its axis. In this respect, however, it agrees with *Taxus*, except that it possesses innumerable seeds; it must be considered to hold the same relation to the other *Cycadeæ* that *Taxus*, with its succulent, cup-shaped pericarp, does to the cone-bearing Coniferæ."

The last-mentioned genus *Mantellia*, named by Brongniart, and with which the genus *Cycadeoidea*, of Buckland, is synonymous, forms the subject of an important memoir by Dr. Buckland, which owes much of its value to the observations of the late Robert Brown, which it contains. Mr. Carruthers points out that the trunks of Mantellia "differ from *Bennettites* in their form, as well as in the more distinctly rhomboidal petioles and the elongated secondary axis. They agree in the nature of the tissues and the method in which they are built up in the stem. The petioles are clothed with a dense ramentum, and they have numerous axillary branches which bore small, simple linear-lanceolate leaves. The branches, when full-grown, are broken off at the point where they leave the bases of the petioles. Sometimes they are undeveloped, and still exist as unexpanded leaf-buds, terminating the shortened branch. These buds are composed of leaves, protected by a very dense and very abundant ramentum. The branches precisely agree with those in Bennettites, and have been, I have no doubt, like them, the supports of the organs of reproduction; only the fruits, having been borne at the ends of elongated and consequently unprotected branches, have been broken off." (p. 701.)

It is earnestly to be hoped that the author of the present valuable Monograph will not leave the stems he has so ably described, destitute of foliage, but that, having given us the very pith of the subject, he will go on to the branches, buds, leaves, and fruits. May we add the hope that Mr. W. G. Smith, who has so ably and truthfully delineated the structure of Cycadean stems, in the ten beautiful quarto plates which illustrate this Monograph, from the remarkable series of specimens in the British Museum, may be specially retained to draw the foliage.—J.M.

II.—JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND. *Second Series.* Vol. vi. Part 2, No. xii. 1870.

THE bearing of Geology upon Agriculture is so prominently shown in the Journals of the Royal Agricultural Society that we look forward with great interest to the publication of the successive numbers. The one before us contains a very pretty geological map of the country around Oxford, including a large area, being bounded by the towns of Reading, Wantage, Lechlade, Stow-on-the-Wold, Banbury, Brackley, Buckingham, Aylesbury, High Wycombe, and Great Marlow. This map, which illustrates a Report, by Mr. H. W.

Keary, on a Farm-prize Competition in the district, was prepared by the Society's Secretary, Mr. H. M. Jenkins, F.G.S., etc. It shows very clearly the geological formations displayed, and also the "surface-deposits" which are scattered over the larger portion of the area.

The latter are classified into Alluvium, Valley-gravels, High-level Drifts, and Scattered Pebbles.

The characters of the soils are only briefly alluded to by Mr. Keary, as his report deals with the management of the several farms described, rather than with the relative capabilities of the lands.

Mr. Jenkins furnishes a note explanatory of the map. The "High-level Drifts" form the *strong land* which so frequently covers the summits of the Chalk and Oolite hills. These include the clay-with-flints, brick-earth, and gravel that cap the Chalk hills. The clay-with-flints is a genuine *soil*, formed, as Mr. Whitaker has pointed out, of the flints and earthy matter left by dissolution of the chalk, together with a clayey and loamy wash from the Tertiaries. It is subject to much variation, in some places being very sandy, while in others there are fields which are literally crammed with flints, with so little soil that it seems wonderful how any plant can find nourishment—yet turnips appear to flourish. Attempts are sometimes made to reduce the quantity of flints by picking off cart-loads of the stones, but they soon "grow" again as thickly as ever —if any appreciable difference is really ever made.

The "scattered pebbles" are, according to Mr. Jenkins, much too scattered to be mapped into distinct beds, but they are of sufficient importance to influence the agricultural character of the surface.

Although on but a small scale, this little map gives as accurately as possible the distribution of the superficial deposits over the country around Oxford, so far as published and other observations have made them known, to which must doubtless be added much personal research by Mr. Jenkins.

It shows the general nature of the sub-soil, and as the farms which competed for the prizes are situated in various parts of the area, it is interesting to notice the systems adopted in each of those described.

We can scarcely hope ever to have a map of England upon which the different soils are traced out, owing to the large scale of the map that would be required. The promised Drift-maps of the Geological Survey will complete the tracing out of the sub-soils, and as these exercise a direct influence on the nature of the soil, they will be of much use to agriculturalists.

The present journal contains other interesting matters which we must briefly notice.

There is a Report on the Farming of Monmouthshire, by Mr. W. Fothergill, which contains a small geological map of the county, and also an account of the soils found upon each formation. The Devonian rocks furnish a great variety of soils;—there is a deep loam especially favourable to the oak and the apple; the conglomerates furnish soils well suited for roots and barley; on the clay a strong wheat-soil is formed, whilst the slaty or shaly beds are best adapted for woodland. The Mountain Limestone soil produces good pasture for the native sheep and cattle. The Millstone Grit appears adapted for sheep-walks only. It has been stated, says Mr. Fothergill, that the worst land in England lies upon the Coal-measures, and certainly, at its best, it is but hungry soil; however, by draining and lining, it may be rendered in a measure productive.

The New Red Sandstone is of well-known and marked fertility, producing in rich abundance every kind of crop.

The Lias furnishes a cold, wet, tenacious clay or clayey loam. When pervious it is found fit for cultivation, and grows good wheat and tares. The Alluvium gives great variety of soil, both in appearance and in productiveness, and this arises partly from deficient drainage, partly from the character of the subsoil, and sometimes from the elevation.

Mr. S. B. L. Druce gives an account of an Embankment and Cutting in the parishes of Standlake, Northmoor, Stanton Harcourt, and Eynsham, in the county of Oxford, made to protect the district from the flood waters of the river Thames. This contains an analysis of soil from Stanton Harcourt, by Dr. Voelcker.

The agriculture of the Scilly Isles is treated of by Messrs. L. Scott and H. Rivington, F.G.S. These islands are almost entirely granitic. The rock is remarkably loose in texture, readily disintegrating, and liable to rapid decomposition, owing to the many joints that occur in it. The granite contains large quantities of iron and felspar, to the presence of which the fertility of the soil is attributed.

To the several other papers in this journal we need not allude, as they have no direct reference to Geology.

REPORTS AND PROCEEDINGS.

Geological Society of London.—Opening Meeting: Nov. 9, 1870. Joseph Prestwich, Esq., F.R.S., President, in the chair. The following communications were read:—1. "On the Carboniferous Flora of Bear Island (lat. 74° 30′ N.)." By Professor Oswald Heer, F.M.G.S.

The author described the sequence of the strata supposed to belong to the Carboniferous and Devonian series in Bear Island, and indicated that the plant-bearing beds occurred immediately below those which, from their fossil contents, were to be referred to the Mountain Limestone. He enumerated eighteen species of plants, and stated that these indicated a close approximation of the flora to those of Tallowbridge and Kiltorkan in Ireland, the Greywacke of the Vosges and the southern Black Forest, and the *Verneuilii*-shales of Aix and St. John's, New Brunswick. These concordant floras he considered to mark a peculiar set of beds, which he proposed to denominate the "Ursa-stage." The author remarked that the flora of Bear Island has nothing to do with any Devonian flora, and that consequently it and the other floras, which he regards as contemporaneous, must be referred to the Lower Carboniferous. Hence he argued that the line of separation between the Carboniferous and Devonian formations must be drawn below the Yellow Sandstones. The presence of fishes of Old-Red-Sandstone type in the overlying slates he regarded as furnishing no argument to invalidate this conclusion. The Sandstones of Parry Island and Melville Island are also regarded by the author as belonging to the "Ursa-stage," which, by these additions, presents us with a flora of seventy-seven species of plants. The author remarked upon the singularity of plants of the same species having lived in regions so widely separated as to give them a range of 26½° of latitude, and indicated the relations of such a luxuriant and abundant vegetation in high northern latitudes to necessary changes in climate and in the distribution of land and water.

Discussion.—Sir Charles Lyell remarked that the Yellow Sandstones of Dura Den in Fife, and of the county of Cork in Ireland, contain *Glyptolepis* and *Asterolepis*, genera of fish exclusively Devonian, or belonging to the middle parts of the Old Red Sandstone—also the genus *Coccosteus*, which is abundantly represented in the Middle Old Red Sandstone, and sparingly, or only by one species, in the Carboniferous formation. The evidence derived from these fishes inclined him to the belief that the Yellow Sandstone, whether in Ireland or Fife, should be referred to the Upper Devonian, and not to the Lower Carboniferous, as Sir Richard Griffiths contended, and as Heer now thinks.

As to the argument founded on the plants, he considered it an important and truly wonderful announcement, that many well-known Carboniferous species are common to Bear Island (in lat. 74° 30′ N.), in the Arctic regions, and to Ireland and other parts of Europe (26° of latitude further south). But fossil plants are supposed to have a wider range in space and time than fossil fish; and we know that the cryptogamic flora of the ancient coal is remarkable for the wide horizontal spread of the same species, extending from North America to Europe, so that we need not be surprised if many species should extend vertically from the Devonian into the Carboniferous strata.

Mr. Carruthers remarked on the bearing of the paper on the Kiltorkan beds, and considered that Dr. Heer had completely established the correlation of the deposits. He differed, however, as to the numerical proportions of the species. He could not recognize *Cyclostigma* as a genus, but considered it founded on insufficient grounds, in which view Prof. Haughton now agreed. It was, in fact, founded on fragments of the bark of *Lepidodendron Griffithsii*, Brongniart, to which species the *Lepidodendron* indicated by Prof. Heer as *L. Veltheimianum*, really belonged. Other detached portions of this same plant had been described by various authors under no less than seven different specific names, and referred to nearly an equal number of distinct genera; and Prof. Heer had reckoned these as species in his comparison of the Bear-Island and Irish floras. Prof. Heer had been led, chiefly by the erroneous determination of the Kiltorkan *Lepidodendron* by the Irish palæontologists, to refer these beds to the Carboniferous rather than to the Devonian formation, the Kiltorkan fossil having been established as a very distinct species by Brongniart and Schimper. Mr. Carruthers considered that both the Irish and Bear-Island deposits belonged to the Devonian.

Mr. Boyd Dawkins pointed out that the proximity of land was exhibited by the presence of terrestrial plants in the deposits, and believed that this might have much to do with the difference in the proportion in the beds. As the marine fauna decayed more rapidly than the terrestrial, it was preferable for classificatory purposes. He mentioned forms of vegetable life which had been recently discovered in America in beds of Cretaceous age. He did not believe that corals could have existed in those high latitudes under anything approaching to the present condition. Prof. Nordenskjöld had failed to discover any traces of glacial action in these beds; and the question arose whether there had been any change in the position of the Pole or in the radiated heat of the sun.

2. "On the Evidence afforded by the Detrital Beds without and within the North-eastern part of the Valley of the Weald as to the mode and date of the Denudation of that Valley." By S. V. Wood, Jun., Esq., F.G.S.

The author commenced by discussing the various hypotheses that have been proposed to explain the denudation of the Weald Valley. In his opinion the upheaval of the district took place in Postglacial times, and subsequently to the deposition of the gravels of the Thames Valley, of East Essex, and of the Canterbury heights; and the denudation was effected chiefly by tidal erosion during gradual upheaval in an inlet of the sea, aided by the action of fresh water flowing into this inlet from the north by streams draining the land which now constitutes the counties of Middlesex and Essex. The chief evidence in favour of his views is as follows: 1. The absence from the Glacial beds of Essex of any débris representing a considerable denudation of the Weald during the Glacial period, and the probability that the Wealden area was beneath the sea during the deposition of the Boulder-clay. 2. The comparative absence of Lower Cretaceous or Hastings-sand materials from the Postglacial gravel-sheets outside the north of the Weald. 3. The impossibility of reconciling the presence of Tertiary pebbles in certain Weald-gravels with an origin by means of streams flowing in the direction of the present rivers. 4. The antagonism between the character of the major valley of the Weald and that of any excavation producible by the agency of rivers. 5. The persistence of the old coast contour with the river-drainage entering it from the north. 6. The existence of a cause, in the shape of an isthmus at Dover, sufficient to induce a strong tidal scour.

DISCUSSION.—Mr. Godwin-Austen thought that the author had done his theory injustice in presenting only a portion of the Wealden area for consideration. He remarked that phenomena similar to those of the Weald were to be found in various parts of Western Europe. He was glad to find that Mr. Searles Wood did not regard the escarpment as representing marine cliffs; but he did not attach sufficient weight to the absence of any material of marine origin at their base; so that there was no evidence of the presence of the sea within the Wealden area. He differed wholly from the author as to the age of the gravels; for beneath the gravels were silty beds containing Elephant-remains. These gravels he was inclined to refer to a Glacial period, as they contain blocks such as could only have been transported by the agency of ice. The elephants found in the valley of the Wey are of the species *E. primigenius*, which also occurs in the Selsea beds; and he believed both to be of Glacial age. As to the theory of the denudation of the Weald, he professed himself a convert to the views of Messrs. Foster and Topley, and cited what was now going on in Heligoland in illustration of atmospheric denudation.

MR. WHITAKER observed that the present absence of gravels along parts of the valley of the Thames affords no proof of their not having formerly existed. He pointed out the soft and friable nature of most of the rocks of the Wealden, which would account for their absence in the gravels. The only really hard rock was the Chert of the Lower Greensand, which was abundant in the gravels of West Kent. Angular flints occurred at the base of the chalk escarpment wherever it had been carried back by denudation. The major valley of the Weald had been spoken of; but he denied that any such valley existed; it was merely a series of numerous small valleys. He could not conceive the rivers flowing against the dip of the strata, as supposed by Mr. Wood. He did not agree in the view of the denudation of the Weald being such an enormous affair, but thought that it might be due to comparatively small causes.

The President pointed out that beyond Southend there was a section precisely similar to that of Grays. It was a mistake to suppose that pebbles from the Wealden area did not occur in the Thames gravels. He thought that much of the denudation of the Wealden area might have taken place before the Glacial period. The presence of Tertiary pebbles in the Wealden area might readily be accounted for by their presence at the edge of the escarpment.

Mr. Searles V. Wood, jun., in reply, justified himself for having limited his observations to the northern part of the Weald, as it was there only that it could be brought into juxtaposition with the Glacial beds. He maintained that, under certain circumstances, no beaches or marine beds were formed at the base of sea-cliffs. He pointed out that in Postglacial gravels large blocks of rock were frequently found, and protested against limiting all ice-transport to the glacial period. He could not recognize the Selsea beds, with 150 living species, some of southern character, and none extinct, as Glacial. He did not acknowledge the alleged softness of the Wealden rocks.

EDINBURGH GEOLOGICAL SOCIETY.—The 37th Anniversary Meeting of this Society was held in its apartments, 5, St. Andrew Square, on the 3rd November, 1870. Mr. Panton read the Report on the state of the affairs of the Society for the past session, and Mr. Richardson submitted the Report of the Delegates from the Society to the September Meeting at Liverpool of the British Association. Both Reports were approved of. The following gentlemen were appointed officers for session 1870–71:—*Patron*, Sir Roderick I. Murchison, Bart.; *President*, Archibald Geikie, F.R.S.; *Vice-Presidents*, H. Alleyne Nicholson, M.D., M.A., James Haswell, M.A.; *Honorary Secretary*, George A. Panton, Birkhill, Hope Terrace; *Treasurer*, George Lyon; *Librarian*, Ralph Richardson, W.S.; *Curator of Museum*, Alexander Somervail; *Councillors*, Right Hon. Lord Rosehill, James Gowans of Gowanbank, John Russel, Lord Dean of Guild, R. M. Smith, F.R.S.E., William Drummond, S.S.C., James H. Sanderson, Goldsmith.

November 17th, 1870. At the first ordinary meeting of the session held this evening, the following paper was read:—"On the Correlation of the Silurian Rocks of the North of England with those of the South of Scotland." By H. Alleyne Nicholson, M.D., D.Sc., F.R.S.E., etc.

In this communication, the author gave a general view of the subdivisions of the Silurian Rocks of the North of England, and of the Southern Highlands of Scotland, with a view of showing how far the two series were comparable with one another. The Silurian Rocks of the North of England were shown to consist of the following members:—1. Skiddaw Slates (= Quebec group of Canada, and base of the Lower Llandeilo of Wales). 2. Borrowdale Series or Green Slates and Porphyries (= Lower Caradoc). 3. Coniston Limestone (= Bala Limestone). 4. Graptolitic Mudstones (Upper Caradoc). 5. Coniston Flags (= Denbighshire Flags, ?). 6. Coniston Grits (Lower Ludlow). 7. Kendal Rocks (Ludlow). The sequence of the Silurian Rocks in the South of Scotland was more obscure, but by the researches of Murchison, Nicol, Geikie, Harkness, and others, amongst whom Mr. Lapworth, of Galashiels, deserved a most honourable mention, it was now possible to form some clear idea as to the general grouping of these rocks. Probably the following might be provisionally adopted as the subdivisions of the Silurians of the South of Scotland. 1. Hawick Rocks, the so-called Bolton Rocks, of uncertain age. 2. Moffat Rocks (= Upper Llandeilo). 3. Girvan Limestone (= Caradoc Limestone). 4. Gala Group, comprising the Abbotsford Flags, the Gala Grits, the Buckholm Sandstones, and the Greiston and Thornilee Slates (this group is probably comparable with some of the beds which succeed the Girvan Limestone, and also with the Coniston Flags and Grits). 5. The Balmae Rocks (= Wenlock Shale). 6. The Ludlow Rocks of the Pentland Hills.

The author pointed out the resemblances which he thought might be laid down between the above and the Silurians of the North of England. He drew attention to the fact that the Wrae Limestone of Peebleshire might very possibly be the equivalent of the Bala Limestone of Wales, and the Coniston Limestone of Cumberland and Westmoreland; and that this would considerably simplify the elucidation of the Scotch Silurians. He showed, however, that much work must yet be done before it would be possible to speak with any certainty as to the correlation of these ancient deposits.

CORRESPONDENCE.

HALL'S MINERALOGIST'S DIRECTORY.

Sir,—Owing to absence from home, I have only just seen B. J. R.'s letter in the Geological Magazine for September.

Few tasks can be more difficult than the preparation for the first time of a work which deals with so extensive an area as that of the British Isles; and whilst thanking B. J. R. for his notes on the Cornish localities, I may repeat the assurance contained in my preface that notices of omissions or errors, and any additional information, whether publicly or privately sent to me, will be gladly received for insertion in a future edition. The value of any such communications will, however, be much enhanced if accompanied by the name and address of the writer.

B. J. R. takes exception to the names Towanite and Limnite, and asks why I have used them instead of either Chalcopyrite or Copper pyrites, and Limonite respectively. With regard to the first of these minerals, I may say that the names Chalcopyrite and Copper pyrites were both abandoned by me in order to avoid the use of the term "pyrite" as applied to an ore of copper. It must be remembered that the name Pyrite was originally given to one specific mineral, the Sulphuret of Iron, from its property of striking fire with the steel; and as the corresponding ore of copper, from its comparative softness, does not possess this quality, the appellation seemed to be a decided misnomer. At the same time I do not justify the use of the synonym Towanite,[1] further than to say that in default of any better name it appeared to be the least objectionable of the three.

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[1] I think B. J. R. will find he is mistaken in supposing that "Towanite" was ever employed by Greg and Lettsom to represent a modification of chalcopyrite.

In deciding upon the relative merits of the synonyms Limnite and Limonite, I was led to reject the latter, because it was already adopted by some of the foreign geologists to designate one the beds of the Neocomian series; and, further, that having a due regard for its Greek origin, the pronunciation of the word Limonite would be very different from that which is usually assigned to it.

I think it will be some time before mineralogists are able to determine whether this mineral occurs most frequently in a marsh (λίμνη) or in a meadow (λειμών); but as the two names have always been looked upon as synonymous, I preferred to adopt the one which had the double advantage of being pronounced as it is spelt, and which is hitherto unappropriated as a geological term.

Pilton, Barnstaple,
October 22, 1870.

Townshend M. Hall.

GEOLOGY OF THE LAKE DISTRICT.

Sir,—I have read Mr. Mackintosh's paper in the October number of the Geological Magazine, and having helped to survey several portions of the Lake District mentioned by him in his paper, I feel bound to record my dissent from some of his views, and my disbelief in the accuracy of some of his observations.

The valleys of Kentmere, Long Sleddale, and Bannisdale, contain plenty of Moraine stuff with scratched stones; in the last-named there is a fine moraine spanning across the middle of the valley, and I believe that the old lake represented by the alluvium of Kentmere originated partly from damming by a moraine, the remains of which may still be traced. On the high ground between Kentmere and Long Sleddale there is abundance of drift, and moraine stones are very numerous. The basin of the Skeggles water which lies on the high ground between these valleys was probably scooped out by ice. I have met with glacial striations running nearly east and west near this tarn, but have not observed the north and south ones mentioned by Mr. Mackintosh, at least I do not remember having seen them, although, no doubt, they exist; but not having my maps at hand, I cannot speak with certainty upon this point. My own impression, however, was that at a late period of the Glacial epoch, ice had passed across the fell, though no doubt at an earlier period it had moved in the direction of the axes of the valleys.

I have, as a general rule, observed that glacial striæ low down in the valleys run in the direction of the valleys themselves, but that on the sides of the hills they usually take an oblique direction to the valley-axis. I have seen nothing resembling "the old sea-cliff" at Elleray, mentioned by Mr. Mackintosh.

I do not agree with Mr. Mackintosh in his conclusion that because the ridge of School Knott is striated transversely to its general trend, that the hollows on either side of it have not been formed by land-ice moving in the direction of their length. I think it quite possible that that which Mr. Mackintosh endeavours to disprove may have taken place, and partially helped to form those depressions, although the evidence may not be strong in support of such a view.

Mr. Mackintosh does not seem fully to appreciate the fact that these valleys have been filled with ice, and that it has not merely filled them, but passed over the fells which divide them.

What Mr. Mackintosh will endeavour to prove from the observations he has recorded, I cannot venture to predict, and so will wait patiently for the *dénouement*.

Frank Rutley,
Geological Survey of England and Wales.

ON A COLUMNAR CLAY-BED IN TIDESWELL DALE, AND ON SO-CALLED PHOLAS-BORINGS IN MILLERS DALE.

Sir,—Allow me to express my general concurrence in the views put forth by Mr. Edward Wilson, in your last number, as to the nature of the altered Clay-bed in Tideswell Dale. I only awaited a full report of the Rev. J. M. Mello's paper, as read to the Geological Society, before publicly expressing my belief in the volcanic nature of the beds in question. I have, on two occasions during the last summer, examined very carefully the Tideswell marble-quarry, and certainly a more instructive section could not be desired. Mr. Wilson's description of it leaves little to be said. We have at the lower part of the quarry, a coral reef converted into a bed of hard massive Limestone marble; upon that a thin layer of ash; then a deposit of red clay, varying in the open section from a thickness of about five feet at one end of the quarry, to from twelve to fifteen feet at the other; and upon this, with a *well-defined line of demarcation*, lies the Toadstone, which is probably twenty feet in thickness at the middle of the quarry, but which is much wasted by denudation in other parts. One inference only seems to me inevitable, viz.: that we have before us in the quarry a complete record of an eruption, during which lapillæ were first thrown down; then an outflow of ferruginous mud took place; and, finally, a bed of lava was ejected, which must, in this place at least, have flowed with so steady and majestic a movement that it rolled over the mud without displacing it; hence the nearly horizontal line of division is clear and well defined to a remarkable degree.

One singular and striking fact seems to have escaped the notice of Mr. Wilson. At the north-west end of the quarry, where the Clay-bed is the thinnest, the hexagonal columns are from three to four inches in diameter, and they extend from the upper to the lower boundary of the bed; whilst at the other end of the quarry, where the Clay-bed has a threefold thickness, the columns are only about one inch across, and they die away in the amorphous clay of the lower part of the stratum. Important deductions might be made from this fact as to the persistency of the heat of the superincumbent Lava-bed at the time of its deposit.

I consider that the Tideswell quarry settles for ever the question as to whether or not this bed of Toadstone, at least, was or was not intrusive in its origin. No one looking at the section can fail, I think, to come to the conclusion that the Toadstone-bed was a sub-aerial or submarine deposit of prior age to the higher Limestones in the series, which elsewhere rest upon this bed.

I may mention that I possess some exceedingly beautiful specimens of miniature basaltic-like columns in common brick-clay, that were picked up by a friend in a field where clay had been burnt for agricultural purposes. These resemble very closely the columnar clay in the Tideswell quarry.

In reference to another subject, I may remark that in going to and from the quarry in question, I passed, on each occasion, through that part of Millers Dale where the Rev. T. G. Bonney (see GEOLOGICAL MAGAZINE, Vol. VII., p. 267) says he found apparent burrowings in Limestone. I sought carefully for these hollowed Limestones, but found none; and I am driven to the belief that Mr. Bonney, in his hurried visit, mistook a bed of Toadstone—a trap-bed much lower in the series than the one above mentioned and which runs along the valley at the road-level for a great distance—for Limestone, and that the vesicular cavities which abound therein were mistaken for the borings of animals. This error could of course only have arisen from a very hasty examination of the locality.

BURTON-ON-TRENT, 14 *Nov.*, 1870. EDWIN BROWN, F.G.S.

BURIED SEA-CLIFFS *v.* FAULTS.

SIR,—In your number for April, at page 192, is a paragraph headed "Buried Sea-cliffs *versus* Faults." This met a reply by Mr. H. B. Woodward in the Magazine for May, with whose remarks I fully concur. I wish to add, that in the year 1846, at the Meeting of the British Association at Southampton, I showed a section of the railway between Bristol and Taunton. At four places the sections were enlarged, one of which represented, on the scale of 40 feet to the inch, the Uphill cutting. An abstract of my communication appears at page 59 of "Reports of Sections," vol. for 1846, and in it occurs the following paragraph:—"At the Uphill section, not only are violent dislocations of the Red Marls and Lias produced, so that the Lias-beds dip at an angle of 70° or more towards the plane of intersection between the Lias and the Limestone, which plane itself dips in the same direction, but in addition, the igneous rock appears in full force; and it clearly bears relation, not only to the fault which brings into juxtaposition the Limestone and Lias, but to an extensive fault in the Limestone itself, by which the whole series of beds on one side differs from that on the other."

My principal object in writing this is to state that these sections were deposited in the Jermyn Street Museum, and may be seen on application. An examination of the Uphill cutting will satisfy any person that it cannot be adduced in evidence of the theory of "Buried Sea-cliffs *versus* Faults." WILLIAM SANDERS.

HANBURY LODGE,
The Avenue, Clifton, Bristol.

ON THE ERRATIC BLOCKS OF THE SKIDDAW DISTRICT.

SIR,—Having been away from home, I have only just seen Mr. Mackintosh's paper in the October number of your Magazine. I have not time now to enter into details about it, from which also I should be precluded by my position in the Survey. I think too that the interesting papers by my colleagues, Mr. De Rance and Mr. Ward, have pretty well exhausted the subject; and a very important paper, referring chiefly to the Glacial action round Bowfell, was read the other day before the Manchester Philosophical Society, by Mr. Brocklebank.

I would, however, ask Mr. Mackintosh how he accounts for the fact that in the drift in Dunmail Raise no traces of Skiddaw Rocks, either Slate or Granite, are to be seen. Mr. Mackintosh finds marine drift in Kirkston Pass, at a level of at least 1,300 feet above the sea. Dunmail Raise is less than 800 feet, and a current passing through it from North to South would, if bearing icebergs, bring fragments of the rocks of Skiddaw, which may be seen from the Pass any clear day.

I believe I am right in stating that all the boulders of Skiddaw Granite that have been found are in a line passing through Bassingthwaite and Troutbeck. GEO. HYDE WOLLASTON.

H.M. GEOLOGICAL SURVEY, GRASMERE, *Nov.* 22, 1870.

MISCELLANEOUS.

AWARD OF GOLD MEDAL OF THE ROYAL SOCIETY TO THOS. DAVIDSON, ESQ., F.R.S., F.G.S., V.P. PAL. SOC. LOND.—We are sure it will gratify our geological friends to learn that Mr. Davidson has been awarded one of the Royal Medals of the Royal Society, in recognition of his valuable contributions to Palæontology. It is not our intention to enter into an account of Mr. Davidson's labours on the Brachiopoda here, as we hope to do so more fully in our volume for next year. We may, however, mention that he has already published 2,090 pages of text, and 336 plates, the latter drawn with his own hand. The greater part of Mr. Davidson's labours have been published by the Palæontographical Society, of which he is the Vice-President: many of his plates will also be found adorning this Magazine.

THE COAL-FIELDS OF NEW SOUTH WALES.—Mr. William Keene, Examiner of the Coal-fields, in his official report for the year 1869, states that the quality of the New South Wales coal is year by year better appreciated. In Madras it meets English coal at equal prices, and it is greatly esteemed for gas manufacture. New works are in progress in various directions. He has examined seams more than 700 miles to the north of Newcastle, belonging to the same deposits, worked near this town in New South Wales; and he remarks that the whole coal-field may claim to rank with the most extensive in the world. 913,246 tons of coal, and 6,276 tons of oil-coal and shale were raised during the year, while 2,012 persons were employed in the labour. There are 21 collieries in active operation, and three Kerosene Shale mines.

MINING NOTES FROM AUSTRALIA.—*Victoria.*—Reports from Sandhurst are very satisfactory; this gold-field is regarded as second in importance only to Ballarat. Its yield per month seems to vary from 17,000 to 21,000 ounces of gold, equal in value to from £68,000 to £84,000. The Berlin district has latterly surpassed any field for the heavy character of its gold, and has earned for itself the name of the "Nuggety Diggings." One nugget, weighing 93lbs. 6oz., is reported to have been found in this field. The number of reefs in the colony, actually proved to be auriferous, is stated to be 2,911; and 62,206 miners are employed on the various fields.

New South Wales.—Near Mudgee, gold has recently been found in abundance, including some very fine nuggets, consequently a new rush has been made to this locality. A good many diamonds are also found at Mudgee, 994 were sent off by one mail last May.

South Australia.—A new silver-lead mine has been opened at Angaston. A rich vein of copper ore, yielding 76 per cent. of the metal, is reported to have been found at the Sliding Rock mine.

Queensland.—The whole country, from the Gilbert down to the head of the Gulf of Carpentaria, is being prospected, and gold is reported as being discovered in all directions. Copper and silver have likewise been proved in places.—*S. W. Silver and Co.'s Circular.*

NOTE ON *Palæga Carteri* (H. Woodw.).—Referring to "Contributions to British Fossil Crustacea," November Number, p. 495, Mr. J. Saunders, of Luton, writes to inform us that neither of his specimens of *Palæga Carteri* (see Pl. XXII., Fig. 5 and 6) are actually from the "Chalk-rock," as stated by us, but from an overlying bed adjacent to the Marl. There is, at least, one other bed between this and the "Chalk-rock," and Mr. Saunders suggests that this correction in geological position will probably bring his specimens from Luton nearer to the same horizon from which the Cambridge and Dover examples were obtained.—H. WOODWARD.

SERIOUS INDISPOSITION OF SIR RODERICK MURCHISON, BART.—We deeply regret to learn, just as we are going to press, that our valued friend and noble chieftain, Sir Roderick I. Murchison, Bart., the Director-General of the Geological Survey, has been stricken down by serious illness. Even at his ripe age, it is not too much to say that he is one of the leading men of the day whom we cannot afford to spare. Two great Societies—the Royal Geographical and the Geological—look to him as to one of their veteran leaders, whose place cannot readily be filled. To the Geological Survey, also, his loss would tell most heavily. We trust so valuable a life may yet be spared to us, if only for a brief season.

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ERRATA.

Page 155, line 12 from top, *for* Gaudy, *read* Gaudry.
„ 263, end of line 9 from top, *add* Edit.
„ 267, line 10 from top, *for* J. H. Green, *read* A. H. Green.
„ 267, title of paper, *after* By, *insert* The Rev.
„ 278, line 11, *after* not, *insert a second* not.
„ 348, line 26 from the top, *after* Ant, *insert* is Tertiary.
„ 348, line 12 from the bottom, *for* millimètres, *read* milligrammes.
„ 422, line 15 from bottom, *between* "and" and "when," *insert* the second shows that.
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„ 521, line 4 of explanation of fig. *for* amygdaloidæ, *read* amygdaloidal.
„ 539, last line but one, *for* reposes, *read* repose, or else in line above, *for* contain *read* contains, and *dele* the "and" before "which."
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